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THE "ROBERT FULTON." A RECORD IN RIVER STEAMBOAT CONSTRUCTION.

THE conditions involved in planning the steamer "Robert Fulton," now under construction at the yards of the New York Shipbuilding Company in Camden, required:

First. The quickest delivery possible, as it was absolutely necessary for the steamer to go into commission on May 29th.

Second. To get as much carrying capacity as consistent with a quick-moving beam engine in a steamer of under 7 feet draft, required to make twenty-three miles per hour.

Third. To get such lines as to insure a good stability in a steamer carrying no cargo, but a shifting load of human freight, which according to wind or run conditions would drift to the shady side or to the forward end of boat with a stern wind, or to the after end with a head wind, and also to keep the lines of the hull in such refined entrance to the water and clean run aft, as to give the minimum disturbance or swell, which would tend to bother tows and smaller boats in the river.

Before tenders were invited or specifications could be made, the steel bulb angles for frames and deck beams were ordered by cable from Scotland, as the dimensions required are not made in this country; and it is of interest that these same bulb angles arrived in the shipyard within twenty-four hours of the time they were wanted.

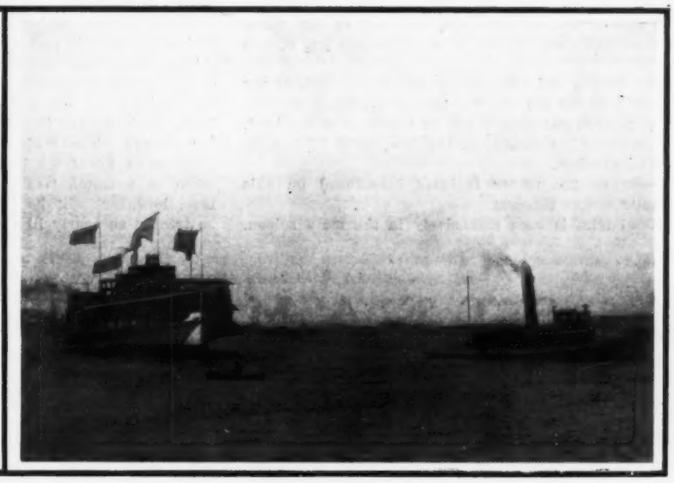
Frank E. Kirby, D.E., consulting engineer, and J. W. Millard, naval architect, worked continuously on the plans and specifications, and the yards desiring to bid on the work were notified by wire as to time of giving out specifications, and notice was given that tenders would be required within five days.

Coincident with making and giving out specifications, the lines were developed and forwarded to Prof. Sadler, of the University of Michigan at Ann Arbor; and he had a paraffine model made from these lines, and tried it out in the model basin to check up estimates of resistance, stability, and the wave-making quality. As a result of these tests, a slight refinement of the model was made; and, meanwhile, the tenders had come in and contract was awarded. The hull and joiner work were given to the New York Shipbuilding Company of Camden, and the engine outfit to the W. & A. Fletcher Company of Hoboken. From the time of awarding the contracts, practically all parts of the complete steamer have gone on simultaneously. As an example, the pilot house, the large dome, the Oregon pine decking, the furniture and linen, the frames, plating, etc., and all parts of the engine started at practically the same time, and from 400 to 600 men have been engaged daily. As the work is all done under cover, not a minute's delay has been caused by weather conditions; and as the electric lighting system in the yards is so complete, the work has been pushed far into the night. There is every reason to be confident that the "Robert Fulton," whose keel was laid January 9th, and whose launch took place March 20th, will go under her own steam to New York about May 20th, and enter in the regular service of the Hudson River Day Line between New York and Albany as a completed structure on May 29th, two months and ten days from laying of keel to launching, and two months and ten days from launching to actual service.

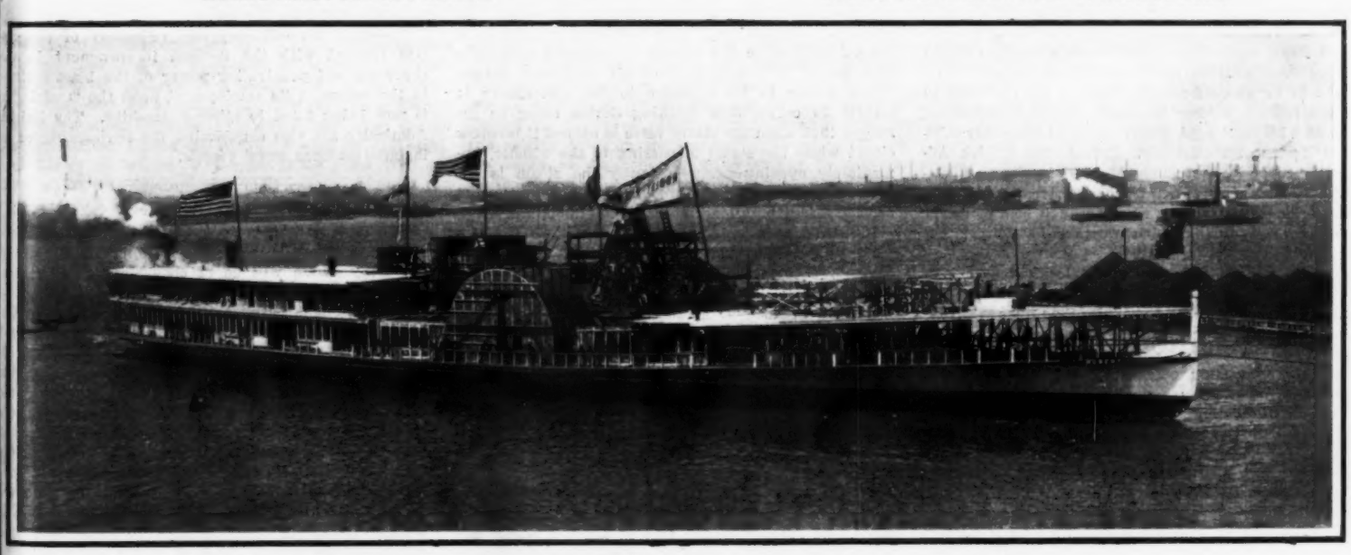
The principal dimensions are:

	Ft.	In.
Length between perpendiculars	336	..
Length over hull molded	346	..
Breadth of hull molded	42	..
Breadth over guards molded	76	..
Depth base line to top of deck beams at side of hull at lowest point of sheer	12	4
Crown of deck beams in 76 feet	..	12

MAKING READY FOR THE LAUNCH.



TOWING THE VESSEL TO THE OUTFITTING DOCK.



Length, 346 feet. Beam, 76 feet. Depth, 12¼ feet. Horse-power, 3,850. Speed, 23 miles. Passenger capacity, 4,000.

LAUNCH OF THE "ROBERT FULTON" IN TWO MONTHS AND TEN DAYS AFTER THE KEEL WAS LAID. A RECORD IN RAPID CONSTRUCTION.

THE NEW HUDSON RIVER DAY LINE STEAMER "ROBERT FULTON."

She is fitted with a beam engine, 75 inches diameter of cylinder by 12-foot stroke, driving feathering paddle wheels 30 feet in diameter. A complete outfit of auxiliary machinery is installed; including steam turbine electric generator, turbine ballast pumps, sirocco blowers, steam fire pumps, etc. Steam gypsy capstans are fitted on each side at the gangways to facilitate quick landing. Three lobster-back boilers are fitted in the hold for supplying all the steam.

A glance at a few of the dimensions of plating and framing will give an idea of the care taken to insure lightness, while, at the same time, great rigidity has been obtained by the spacing of the frames, keelsons, and bulkheads, and the steel framing of the entire superstructure.

The main frames are of bulb angles 4 inches x 2½ inches by 8 pounds, spaced 24-inch centers.

The floors are of flanged steel plate 15 inches deep by 12½ pounds weight.

The main deck beams are of 4 inches x 2½ inches x 8 pounds bulb angles on every frame.

Shell Plating.—The landing edges of all outside strakes, except the garboard and sheer strakes, are joggled. All butts strapped.

The sheer strake is 45 inches wide and 17½ pounds per square foot for 100 inches amidships, gradually reduced 1 pound per square foot at a time to 10 pounds per square foot at the ends. In way of the wheel opening the sheer strake is of 20 pounds per square foot.

The bottom and side plating are of 12½ pounds per square foot for 150 feet amidships, gradually reduced to 10 pounds per square foot at the ends of the boat.

The waterline strake, at the bow, is of 12 pounds per square foot.

Some of the newer features introduced on this steamer are as follows:

Metal trim is used extensively in the main saloon. It is constructed of wrought iron in delicate and graceful design and finished in natural color. The cabin decks and everything below them are of steel. Partitions in galley and crew's quarters are of steel. Uptakes from kitchen, boiler, and engine inclosures are all of steel and carried above the entire superstructure. All of the underside of the main deck over quarters, kitchen, boilers, and engine compartments is covered with asbestos and steel.

In order to insure an even keel and proper fore and aft trim, a large trim tank holding 20 tons of water is located on each guard just aft of the wheel; and a ballast tank holding 30 tons of water is located in the hold at the extreme after end. Electric power is supplied from a low-pressure turbine generator. Food is cooked by a high-pressure steam cooker. Dishes are washed by an electric dish washer. The wainscoting on the main deck and in the dining room, also the entire floor of the dining room, are made of asbestolith, which is absolutely fireproof. All clear glass windows throughout the vessel are of plate glass. Colored glass is furnished by Tiffany's studios.

The life preservers, 4,000 in all, are of balsa wood and cork, with all jackets fireproofed. The steel shell is protected on the inside below decks by the bitumastic preparations. The furniture is of specially designed wicker, which combines lightness, strength, coolness, comfort, and cleanliness.

The large lunch room, which is a special feature on this steamer, occupies the entire forward hold from the engine-room bulkhead to the second collision bulkhead. It is treated in ship cabin style and is a popular feature. The dining room is aft on the main deck, as in all of the Day Line steamers, and is finished in a Dutch treatment. The most unique feature, however, will be the main saloon, which will be treated as nearly like a garden as is possible, and will be green and summery and entirely unlike any saloon afloat.

As the "Robert Fulton" commemorates a great anniversary and bears the name of the first marine engineer, the treatment of her mural decorations is made to embody as much of a historical character as possible. A pictorial history of steam on the Hudson has been arranged and executed by Mr. S. Ward Stanton, probably the best living authority and a most conscientious delineator. As the Hudson River is the birthplace of the commercially successful steamboat, it seems entirely fitting that special prominence should be given to the leading types of steamers, which show the early development and various steps in the advance of steamboat construction.

Pictures of New York, Albany, Kingston, and Hudson from the best available data, and the homes of Chancellor Livingston, Beverly Robinson (Andre's Headquarters) and the old Yankee Doodle House, all of a period of about one hundred years ago, are executed by Mr. Vernon Howe Baily. Also there will be portraits of some of the most distinguished characters in the history of the river, including Robert Fulton, Chancellor Livingston, DeWitt Clinton, Washington Irving, and Generals Washington and Wayne. These portraits are being painted by Mr. Robert Fulton Ludlow, a great-grandson of the great engineer Robert Fulton.

In concluding our notice of this handsome vessel, we draw attention to the fact that contemporaneously with the construction of the "Robert Fulton" a replica of the original "Clermont" is being built on Staten Island from carefully collected plans and general data of the boat. In the great naval parade which will form part of the festivities of the coming autumn, the "Clermont," together with a reproduction of Henry Hudson's "Half Moon," now being built in Holland, will hold a conspicuous position.

A STEAM SIREN FOR SHIPS.

AN ELECTRICALLY OPERATED SIGNAL.

A NEW departure in the control of steam sirens and whistles, especially in regard to vessels, has been effected by the new device invented by Mr. Willett Bruce, the superintending engineer of the White Star Line at Liverpool. The importance of being able to effect clear, well-defined blasts from steamship sirens during thick weather, as is well known, is imperative, but it is no uncommon circumstance for the blast to be blurred or lacking in power owing to becoming choked with condensed steam which considerably militates against its efficiency. Indeed, the British Admiralty court in the course of investigations respecting accidents at sea have frequently commented upon this serious disadvantage when through lack of power a siren blast during thick weather has either not been heard or miscalculated.

The Bruce electric-operating device has been contrived especially to overcome this serious weakness and its installation upon the White Star liner "Cedric," where it has been in operation for some months past, has proved so eminently satisfactory that its application is now being extended. The captain of this liner has found it particularly reliable and effective owing to the piercing clearness of its blast especially in passing up the North River to New York.

The electric controlling apparatus is carried in a small box which is placed at the foot of the foremost funnel where the siren is set in position. The mechanism comprises a small electric motor and a timing switch, as well as being equipped with a hand lanyard in case the electrical gear should become deranged during operation. The controller is worked from the navigating bridge in the usual manner by a simple switch. Movement of this governing switch immediately opens a valve which admits the steam to the siren and a clear, penetrating, powerful blast instantly results. Owing to its simplicity and efficiency a system of complete signaling can be effected by the navigating officer from the bridge. The control is absolute and sensitive, as well as being decisive and reliable, while no condensation of idle steam in the siren feed pipe can result so that stifling of the blast, owing to the presence of water, is obviated. The integral parts of the mechanism are strongly made and being few in number are not liable to easy derangement, while in the event of breakdown the whole electrical gear is instantly accessible.

The valve admitting the steam to the siren feed pipe is of special design in order to overcome the resistance of the boiler pressure on its opposite face. When the switch is depressed and the electrical gear set in action thereby, a small pilot valve first opens, admitting sufficient steam to act upon a piston carrying a large control valve upon its spindle, which in turn distributes the steam to the siren. The valve chest itself is placed at the foot of the funnel instead of immediately beneath the siren, as is usually the practice. The section of pipe extending upward from the valve chest to the whistle is equipped with suitable means of draining it of all condensed steam, which owing to its exposure to the atmosphere is certain to occur, this draining device being so arranged that when the steam valve is opened it becomes closed while the steam is passing to the whistle, immediately opening again instantly the steam is cut off. In this manner the pipe is kept constantly and perfectly free of all accumulation of moisture.

If desired, such as in foggy weather, the electric control can be set so that the operation of the siren is effected automatically at predetermined intervals. There is a small series-wound motor, the spindle of which is extended so as to carry a worm which engages with a gear wheel and pinion which drives another wheel to the spindle of which is attached a radial arm. This rotates, and in its revolution according to the setting of the gearing establishes electrical contact, an electro-magnet is energized which opens the main valve admitting steam to the siren, and becomes de-energized when the radial arm passes off the contact, thereby closing the steam valve. This time arrangement can be set to give blasts of any period of duration, and at any regular interval as desired. In foggy weather this is a great advantage, since it insures the warning signals being given with unerring regularity independently of the bridge. The motor with its gearing is mounted on a small baseplate and the gear wheels run in an oil bath. The current consumption of the mechanism and motor does not exceed 2½ amperes. The electro-magnet is of substantial design and construction, highly insulated, and adequately protected against both moisture and damp. The whole is inclosed in a water-tight casing and access is secured from the front, which face is hinged so as to drop downward when the box is opened. The box is attached to the flange of the steam valve-chest and in such a manner that the distance between the electro-magnet spindle and the lever operating the steam valve thereby is not influenced by elongation and contraction according to whether the steam is on or off. The total weight of the apparatus is about 220 pounds.

The navigating bridge equipment, as already mentioned, comprises a simple switch of the two-way type. This is inclosed in a water-tight casing as a protection against weather. The off position is indicated "silent" while one contact position is marked "time control," representing automatic operation of the siren by the electrical timing apparatus, and the opposite "signal control" which signifies operation of the siren when desired from the bridge.

Owing to the efficiency and reliability of the system coupled with the decided improvement in the character and penetrating power of the blast emitted in the course of its employment upon the "Cedric," it is now being fitted to other steamships. The British Admiralty are also considering the advisability of its installation upon naval vessels.

AUTOMOBILES FOR ARMY SERVICE.

THE German Etat-Major has recently taken a decision with regard to heavy automobile cars for use in the army which will be of considerable importance. After considering the problem presented by the adoption of automobile cars for the army service, the Minister of War is of the opinion that it can be solved best in the following way: It is not considered advisable to have the War Department enter into the establishing of a large headquarters containing the great number of cars which will be needed for the service, owing to the great outlay which this would require for the purchase and the maintenance of the cars. One leading point is that such cars would soon become out of date, owing to the continual advance which the industry is making, so that this makes it a disadvantage for the government to purchase a large number of the present types of cars. It is considered that the best method is to favor the development of the heavy car in Germany so that the army will profit by the same. This it has been decided to carry out by means of awarding subsidies to automobile constructors or owners. For the first period including the year 1908 there has been devoted the sum of $200,000 for this purpose, and it will be divided among the possessors of heavy cars of home construction which can be used for the army service, upon condition that they are to be held at the disposition of the War Department in case of mobilization. The cars are required to be kept in running condition for a period of five years. As regards the subsidies which are to be allowed for this purpose, they are divided into three classes of premiums. An initial sum of $1,000 is paid for each car, next a premium for maintenance for each car of $250 annually, and lastly a premium for various material, especially combustible, designed to favor home production of such, the sum to be fixed by the department. The above figures apply to 30-horse-power cars, and for the larger sizes the amounts can be increased.

MAKING MONEY OUT OF WASTE.

USING THINGS THAT WERE ONCE THROWN AWAY.

BY DAY ALLEN WILLEY.

ONE of the most interesting phases of the world's development is the manner in which the people of civilized nations are utilizing so many things which were only recently considered as valueless—to be thrown away as worthless; while what we have thought was useless stuff, merely fit to be trod under the feet as so much dirt, has been converted into a product of great value. The increase in the population of various countries, and especially the increase in the number of inhabitants of great cities, has been one of the reasons why the genius of the inventor has contrived to make what we have called waste of worth to us by using it in various compounds and articles which have already become indispensable. The things that are thrown into the street, house yard, and other receptacles for debris can be used in so many ways, that scarcely anything can now be considered refuse. For instance, old tin cans are melted to be molded into buttons, covers for luggage, and toys for children, which sell throughout the world at Christmas time. Discarded shoes and rubbers, also scraps of leather, have become of value in manufacturing various substances. Not a single bottle or other piece of glass need be thrown away, for mixed with certain kinds of earth and sand, it makes an excellent artificial stone for buildings. Not so long ago dead animals were buried, as it was not known that their bones, hide, and even parts of the intestines were of use. Much of the inflammable composition in the lucifer match is now obtained from such bones. Even the sweepings of the street pavement, containing as they do particles of horseshoes and other metal, are worth gathering; while the bits which fall from the horse's hoof as it is being shod by the farrier make a most valuable dye when mixed with certain chemicals and metal scraps.

Over nearly every large city, especially such centers as London, Birmingham, and seats of other great countries, are enormous clouds of smoke, which so frequently darken the atmosphere that even at noontime it is necessary to have lights in the buildings. Yet this smoke if properly treated can be actually dissolved into several most useful elements—and the inventor has designed apparatus by which these elements can be secured at a small cost. It is a fact that smoke can be weighed and measured like so much earth and sand. Experiments which have been made in the United States show that a cord of ordinary fuel wood in burning generates 28,000 cubic feet of smoke. If the smoke from 100 cords of wood is treated by this process, it will yield no less than six tons of the valuable chemical known as acetate of lime, besides 25 pounds of tar. But the smoke contains so much of the element of alcohol, that this quantity will produce no less than 200 gallons of spirit suitable for lighting, heating, or the operation of motors.

Usually perfumes and other useful odors are considered as being obtained principally from flowers. The oils coming from waste fruit, such as decayed pears, grapes, and peaches, however, can be substituted for some of the most costly floral odors after being treated with acids and other liquids which give them a remarkable fragrance. Perfume, soaps, even confectionery, are now manufactured, which are flavored with what is called the oil of bitter almonds, but which is extracted from the tar which is a refuse of gas-making plants such as are to be found in every large city.

The enormous production of iron and steel in various forms has caused great furnaces to be erected for smelting this metal in large quantities. Here again a study has been made of what can be done to use what was formerly waste. Even the gas which in the past has been allowed to escape in the air has been made prisoner, so to speak, and converted into a most valuable factor. The mixture left after the iron has been extracted from the ore—sometimes called slag—which represents the debris of the iron ore, is now one of the most valuable compounds coming from the blast furnace, although but a few years ago it was thrown away. In fact, blast furnaces have been built on the edge of swamps and bodies of water, so that the slag could be thrown into these places and used for filling them up. Very good glass is now made from this slag, as well as paving blocks and bricks, artificial porphyry, and a cement which is equal to the best. Ground with six per cent of slaked lime, building mortar is also made from slag; and ornamental copings and moldings, window sills, and chimney pieces are fashioned of it.

Slag brick is stated to be quite as strong as ordinary brick, and much less permeable to moisture. To make 1,000 brick, 6,000 or 7,000 pounds of granulated slag, and from 500 to 700 pounds of burned lime, are consumed. Good bricks also can be made from granulated slag mixed with dust from slag, though the hardening process is rather slow. Slag is also used for steampipe and boiler wrappings, in which form it is called "silicate of cotton." Coal slag is a good structural material; mixed with slaked lime, it stiffens into a mass weighing from fifty to one hundred pounds per square inch. Basic slag is used in large quantities by manufacturers of fertilizers, instead of phosphate rock.

The greatest metal industry in the world, which is now being built in Indiana, forming an entire city in itself, is provided with iron smelters from which the gas as it rises will be returned to the fires beneath the ore and used for heat. By this system the cost of coal to smelt the ore will be about one-half the expense if the gas were not secured as stated. Waste gas has been utilized by inventors for the direct operation of engines so large that they have a force equal to the power of a thousand horses. As it issues from the smelter, the gas enters a large cover, as it might be termed, placed above the furnace. In the center of the cover is a pipe, through which the gas passes into a reservoir below. From this it is forced directly into the engine, and ignited by an electric spark. This causes it to explode, and the force of the explosion drives the engines and the other machinery.

One of the most important discoveries which has been made in connection with what we have called waste products is the value of sawdust. Usually sawmills produce such large quantities of the material, that it cannot be burned to advantage. It is then thrown away, so to speak, sometimes being piled in great heaps and left to slowly consume. A very good quality of alcohol, however, can be distilled from ordinary sawdust by an inexpensive process, in such quantities that two gallons of the liquid can be obtained from 220 pounds of dust. The sawdust from birch and some other species of forest trees will also yield a palatable sugar after it has been treated with certain chemicals. In America and in some parts of Europe an enormous quantity of the dust is sold, being vended about in wagons and in sacks carried on the backs of the vendors. It is bought to sprinkle on the floors of cafés, butcher shops, and other places where it will prevent dirt from sticking to the floors. In recent years so many dolls and other "stuffed" toys have been made, that the sawdust is used very extensively for this purpose also. It is a fact that there are five hundred sawdust merchants in the city of New York alone, and that they sell what is generally called waste to the value of 400,000 pounds in a single year.

Since the slaughter of cattle, sheep, and other animals on a large scale was begun at the abattoirs in America, France, and other countries, the valuable articles and compounds which have been made from dead animals is really amazing. In some of the American abattoirs the carcass of a single beef may enter into no less than four hundred different articles, ranging from the beef steak for the family table to the buttons sewed on the family clothing. Parts of the animals formerly discarded go into medicines, oils, soaps, brushes and combs, mirrors, household necessaries such as handles for tools, leather for harness and luggage covers. Even the teeth are fashioned into studs and buttons. A list of the slaughter-house by-products which are now utilized for commercial purposes includes hair, bristles, blood, bones, horns, hoofs, glands, and membranes—from which are obtained pepsin, thymus, thyroids, pancreatin, parotid substances, and suprarenal capsules—gelatin, glue, fertilizers, hides, skins, wool, intestines, neat's foot oil, soap stock, glycerin from tallow, brewer's isinglass, and albumen. Albumen is obtained from the blood of the slaughtered animals, and is used by calico printers, tanners, sugar refiners, and others. The bones coming from cooked meat are boiled, and the fat and gelatin which result are used, the former to make soap, the latter for transparent coverings for chemical preparations, and for other purposes. The uncooked bones are used in a variety of ways. From the bones of the feet of cattle are made the handles of tooth brushes and knives, chessmen, and nearly every article for which ivory is suitable. Combs, the backs of brushes, and large buttons are made from horns, which are split and rolled flat by heat and pressure.

Hoofs are utilized according to their color. White hoofs are exported largely to Japan, to be made into various ornaments and imported back as "Japanese art objects." From striped hoofs buttons and horn ornaments are made; while black hoofs find service in the manufacture of cyanide of potassium for the extraction of gold, and are also ground up as fertilizer. From the feet neat's foot oil is extracted, and from various other portions of the body various other oils, all of which are highly valuable. Substitutes for butter, such as butterine and oleomargarine, are made by utilizing the fat of beef and hogs.

In the textile industry the making of value out of waste has been truly remarkable. In the modern woolen factory no fewer than five products are obtained by methods now in vogue, from the greasy excretions which, after circulating through the animal's system, attach to the wool of a sheep. These products are used as a base for ointments and toilet preparations, for dressings for leather, as a lubricant for wool and other animal fibers, and in conjunction with certain lubricating oils. At one large plant in America more than 200,000 pounds of wool are "degreased" every ten hours. From two million to three million dollars' worth of wool fat and potash are estimated to have been wasted during a year in the United States before the solvent process of extraction came into general use.

In the industries of cotton manufacturing and cottonseed oil making, scarcely anything is allowed to go to waste. For many years the seed of the cotton plant was regarded as without value; now the cottonseed crop of the United States is worth about one-fifth of the total cotton crop of the country. Among the principal uses of cottonseed oil are its part in making lard compound and white cottolene, both valuable food products. Cottonseed oil is also used as a substitute for olive oil, by soapmakers in the making of soap, by bakers, and also in the manufacture of washing powders.

The leather industry is equally saving in the matter of wastes. In the tanning of leather, there are developed as side products scrap and skin, from which glue is made; hair, from which cheap blankets and cloths are manufactured, and waste liquors containing lime salts. By means of a special apparatus scraps of leather are converted into boot and shoe heels, inner soles, etc. What is called "shoddy" leather is made by grinding the bits of leather to a pulp, and then by maceration and pressure forming them into solid strips.

But perhaps the most wonderful way in which what we have called ordinary dirt has been made a most valuable agent is in the making of concrete. It is needless to say that what is really concrete all comes from the ground. Even the cement lies in deposits here and there in the earth, and is made ready for use by a very simple process. Mixed with sand which is to be found so abundantly, then combined with crushed stone or gravel, it is only necessary to pour a little water over the compound to create the liquid stone with which the builders are performing such marvelous exploits. Concrete is not only being fashioned into great bridges and monuments, but is being molded into enormous hotels and other buildings, which in America are called "skyscrapers." It forms the linings of huge tunnels and sewers, it is so massive and solid that it is used for great foundation blocks, yet in every case it is a mixture of four of the most common elements known to us—sand, cement, stone, and water.

The advantages of small electrically-driven refrigerating plants were recently discussed before the Franklin Institute. One rather interesting plant described was set up in a florist's shop. A large display case embracing about 500 cubic feet was refrigerated by means of from 500 to 700 pounds of ice per day, this large amount being required by reason of the fact that the case was frequently opened during the day. A small electrical refrigerating machine of one ton capacity has now been erected, and this serves to freeze a solution of brine contained in four tanks. The brine solution is very weak, and has a freezing point of about 26 deg. Fah. The tanks are frozen solid each morning, and the machine is not operated again until toward evening. The system has been found to work admirably even though the door is constantly opened and the temperature may rise at times as high as 60 deg.

PROPELLER MOLDING.*

SOME USEFUL HINTS FOR THE CASTER.

PROPELLER screws are of various forms, and they are made in different ways. The majority are produced in a loam-mold, but some by a core-box, and a few by a pattern. The first-named method is the most accurate, and is almost universally adopted for large propellers. There is little work for the pattern-maker, but very much for the molder. The core-box is used in a good many cases, chiefly as alternative to a pattern in the smaller propellers. Molds may be made in green sand from complete patterns, or from a

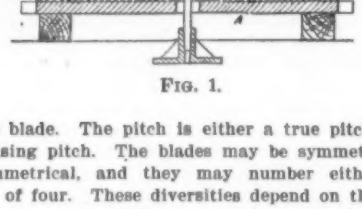


FIG. 1.

single blade. The pitch is either a true pitch or an increasing pitch. The blades may be symmetrical or unsymmetrical, and they may number either two, three, of four. These diversities depend on the original design, with which we are not concerned here.

The first stage in making a true screw-propeller in loam is shown in Fig. 1. A cast-iron plate, *A*, is laid down in the pit or on the floor, and the center striking-bar, *B*, set up in position. A striking-board, *C*, is bolted to the bar, to sweep up a level loam-bed, *D*, on which to build subsequent work. At *a* the body of loam is swept up to form a support to the boss of the propeller. The height of this depends on the shape or lead of the blades, and varies with different screws. This bed is now dried.

The top face of the loamed plate is now roughly marked out (Fig. 2) into as many equal divisions as

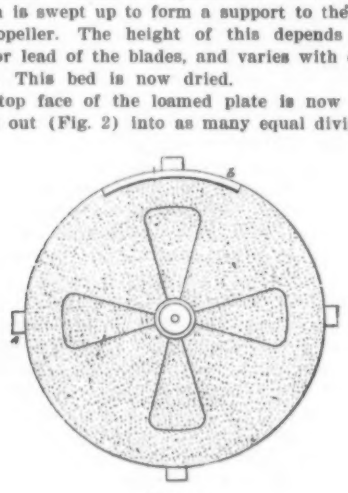


FIG. 2.

there are to be blades in the intended screw—four in the present case—and these centers are guides to the molder in building up the brick beds which are to form the faces of the blades. The areas of the beds must be larger than the areas of the blades, in order to allow room for jointing the copes. They are also rudely triangular in form. But, either before or after these are built, it is necessary to strike up the boss. Pattern-bosses of wood are seldom used in this class of work, but loam-bosses are adopted instead, being much cheaper. These may be swept up in the manner shown in Fig. 3, or a loam-boss may be struck on a bar against the edge of a board, using a bar wound with haybands (Fig. 4), and covered with a thickness of loam. This, when

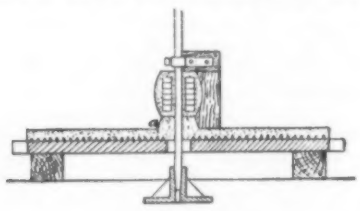


FIG. 3.

dried, is slipped off the bar, and stood up in the center of the mold, just as though made of wood.

If the boss is swept up in place, this may be done before or after the beds for the blades are swept. If afterward, the narrow space necessary for the sweeping round of the striking-board must be left clear, and filled in subsequently.

Fig. 3 shows the boss-board rigged up ready for striking the loam-boss, the loam being supported on the stool *a* in the usual way. The boss struck by the board does not form an actual portion of the mold when finished, but is obviously only a reverse or dummy, against which the actual boss-mold has to be built up, after which the dummy is removed. This is dried after being struck, and strewn with parting-sand, and the building up of the brickwork-beds for the blades follows. This is shown in Fig. 5.

A first course of bricks is laid down on the loamed surface of the plate *A*, as shown at Fig. 5, *E*, inclosing roughly the areas to be occupied by the blades. Before completing the building-up, it is necessary to lay down the templet for the pitch of the blades. This is shown in Fig. 2, *b*. It consists of a piece of sheet iron having its top edge cut to the same angle as the screw-face, and set down at a suitable radius (Fig. 2), occupying the four places corresponding with the blades there shown in succession. The sloping edge becomes the guide for the edge of the striking-board (Fig. 6), *b* being the guide, and *F* the board. The only object in making a framed triangular structure of the board is to impart rigidity, which could not be so well obtained in a single horizontal strip. The bottom edge of the board is set truly horizontal, so that all the radial horizontal lines in the screw are right lines, or straight. A piece of hoop iron is screwed along the lower edges; otherwise the board

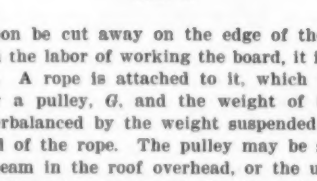


FIG. 4.

would soon be cut away on the edge of the templet. To lessen the labor of working the board, it is counterbalanced. A rope is attached to it, which passes up and over a pulley, *G*, and the weight of the board is counterbalanced by the weight suspended from the other end of the rope. The pulley may be suspended from a beam in the roof overhead, or the upper part of the striking-bar can be fitted with a forked casting to form the pulley bearings.

Often, instead of using a counterweighted striking-board, a plain parallel board only, like that shown in Fig. 1, is employed, pulled up and pushed down by hand alone. In that case, two templets are necessary, one next the boss, in addition to the outer one, *b*.

Frequently a guide-templet of wood is employed, instead of one of sheet iron. It is easily made by the pattern-maker. Being bracketed, it stands upright.

The bricking-up, *E*, can now be proceeded with.

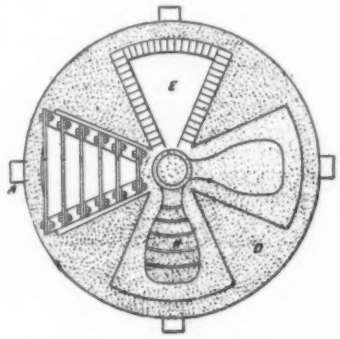


FIG. 5.

Common bricks are built over the bottom, or foundation row already laid down, but they will have to be sloped to follow rudely the contour of the screw-blade. The bricks also must be kept sufficiently far away from the dummy boss to allow of a thick coating of loam to be daubed around that. After the loam is well daubed on, the bricks are bedded well against it, and the work is completed up to the top course. Any odds and ends of broken brick are suitable, cemented with plenty of stiff, coarse loam. This is illustrated in Fig. 7, which represents in elevation the boundary wall of bricks for one blade. Some of the bricks may have to be chipped to the bevel, but small broken pieces will answer as well. When built up, the top face should be about an inch from the bottom or striking-edge of the board. This is for the final coating of loam. But before the loam is laid on, the central space has to be filled in. This is done with cinders and with loam bricks. The cinders occupy, perhaps, one-half of the space, and are used for the purpose of affording a reservoir and free vent for the gas from the surface of the blade. These are covered over with loam-bricks, which are brought up like the common bricks, to within an inch of the striking-edge of the board. Their top faces are also necessarily sloped to the same bevels as the screw-face. The whole of the bricks are well bedded in loam, and

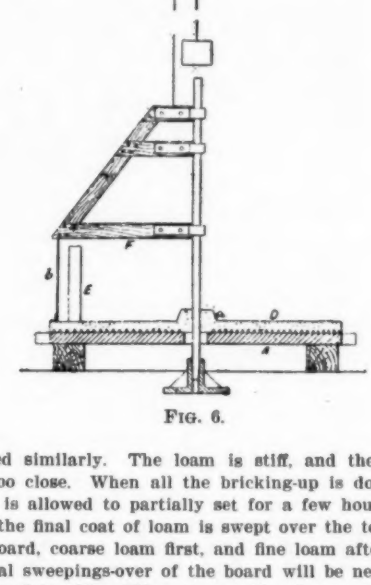


FIG. 6.

jointed similarly. The loam is stiff, and the joints not too close. When all the bricking-up is done, the mold is allowed to partially set for a few hours, and then the final coat of loam is swept over the top with the board, coarse loam first, and fine loam afterward. Several sweepings-over of the board will be necessary to complete this. When a smooth, clean surface is obtained, the plate, with its four blade-beds, is dried, either with heaters or is put bodily into the stove.

The molds for the convex surfaces of the blades are next obtained, in the following way: There are certain thicknesses and sections taken at different radii of the blades, and templets are made to these. Fig. 8 shows a set of such templets, made in wood. The templets are curved to the radius, and their thicknesses and sectional outlines are precisely the same as that of the blades at that radius. Each templet is provided with dowels, by which it is fixed in place upon the bed of the mold, already struck and dried, or it is retained in place with a few nails, driven in round the edges. Sometimes lead templets are made and bent, to save the labor of cutting out sweeped pieces of wood.

The templets being all set upon the mold of the blade face, in their proper positions (Fig. 5, *H*), their interspaces are filled up with sand—properly, a dry-sand mixture—which is strickled over level with the tops of the sweeps. These finished surfaces—reverse molds—are then strewn over with parting sand, and are ready to receive the copes.

Obviously, common molding-boxes would be of no use for these copes, because of the great slope of the backs of the blades, which necessitates a corresponding sloping of the copes. Structures, therefore, very much like core-grids, or a cross between a molding-box and a grid, are used. One of these of a type used is shown in Fig. 9. It is made by casting a number of ribs of suitable shape, and bolting them together with bolts passing through slotted holes cast in the bars. The faces, *a*, *a*, form the joint-faces between the copes and the bricked-up beds. The sloping ribs cover the backs of the blades. The spaces between the ribs are filled up with loam-bricks and broken and coarse

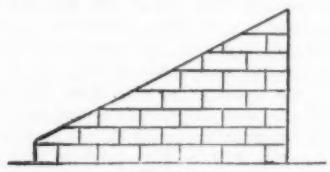


FIG. 7.

loam. The set-off pieces at *b* are utilized for weighting down the top and bottom portions of the mold securely during pouring, as we shall see directly. The patterns for these ribs are fitted over the mold, so that, when all are bolted together, the skeletons of the copes are of the correct shapes.

These copes are made in loam. Parting sand is strewn over the beds, prepared as previously explained. Loam is smoothed over this, and the copes, loamed over also, are laid upon this and pressed down, and dried with heaters. When lifted off, the loam will all adhere to the copes, leaving a clean joint-face

* English Mechanic and World of Science.

at the parting-sand. Some touching up and smoothing over will be necessary, and then the copes are blackened and put into the stove and thoroughly dried.

Meanwhile, the temporary thickness of sand forming the dummy-blade thickness, with the section templets and the dummy boss, will have been removed from the bottom part of the mold, and the surface will be smoothed, blackened, and dried. The copes, being dried, will also be blackened, and now everything can be put together and closed for pouring, and a plain top laid over the boss. Fig. 10 shows the mold com-

FIG. 8.

pleted. The copes are held down with bars, *A*, laid across the set-off pieces cast upon the cope-grids. A ring, *B*, is laid upon these, and weights laid upon the ring. Although not shown in the illustration, sand is shoveled over and around the copes and the bars, so that very little of these details are apparent in a closed-up mold.

Instead of weighting the copes, holding-down bolts are alternately used. In this case, lugs are cast on the cope-grid, and corresponding holes in the bottom plate, *A*, in the figures. And the bolts pass through from top to bottom outside the bricked-up piers. Frequently, then, the cope-grids, instead of being built up, as in Fig. 9, are cast in one piece, with bars across resembling molding-boxes, the diagonal shape being obtained by fitting them down on a swept-up bed. The bottom plate *A*, also, instead of being cast of disk shape, may, in the case of two and three-bladed propellers, be cut out roughly to corresponding outlines. When single blades have to be cast, the methods just described are adopted, the face being loamed on a swept-up pier, and a cope rammed over it.

Many propellers are made in cores, and there are several advantages in adopting this method, especially when the propeller is of a standard size and type of moderate dimensions. Of course, a single pattern blade has to be made and put in the box, together

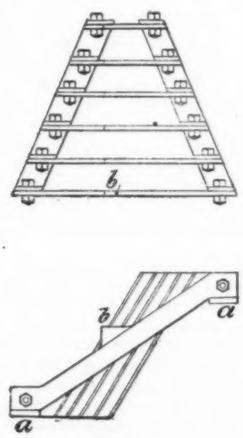


FIG. 9.

with a boss-section. Fig. 11 shows such a box and blade. The box is divided into two portions, the joint following very roughly the twist of the face of the blade. The core is therefore divided at that joint, and the pattern-blade taken out there, and the core is afterward closed. The core is rammed on two grid-plates—one top, the other bottom—by means of which also the cores are lifted and turned about. Fig. 12 shows the cores laid down, and rammed round with sand.

A pattern-blade can be made by various methods, the commonest being by means of overlapping strips glued together and worked through; but the neatest and simplest way to get the correct shape of the blade is to strike a bed, just in the same way as with a sheet-iron templet and board, as when striking the beds for a mold, only that the whole structure would be of a very temporary character, and to use that bed to obtain the correct form of the face of the blade. After the shape of the face is obtained, the rest is easy. The face of the wooden pattern is worked to shape by trial upon this bed. The boss is made separately from the blade, and is bolted thereto subsequently. The plan-angle of the blocking-pieces in the core-box, into which the boss is fitted, is determined by the number of blades in the propeller—90 deg. in the case of four blades, 120 deg. in the case of three blades.

CAB SIGNALS AND AUTOMATIC STOPS.

AN appendix to the annual report of the Interstate Commerce Commission sent to Congress last week reviews the work of the Block Signal and Train Control Board during the first year of its existence. The duties of this board of four signal experts who were appointed in July, 1907, embrace an investigation of block signals, automatic stops, and cab signals and other devices designed to promote the safety of railway operation. So far, the board has confined itself to an investigation of some 371 devices, of which 248 relate to signals and automatic stops. Out of 184 inventions which have been finally passed on only 12 signal and train-stopping devices have been found to possess sufficient merit to warrant the board in recommending an actual service trial. These figures are quoted here as showing in a concrete way the general lack of knowledge of the requirements of apparatus of this character on the part of inventors who waste their time, money, and energy on developing impractical devices. While the object of the investigations of the board has been primarily to discover suitable safety devices applicable to steam railway operation,

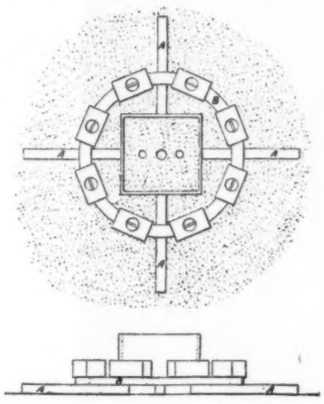


FIG. 10.

the report contains much of interest to electric railway managers. The fundamentals of safe operation of railway cars or trains are the same whether the motive power be steam or electricity.

One of the subjects discussed by the report and of special interest to electric railway managers relates to automatic train stops worked in connection with fixed visual signals, a safety device whose use has been confined to date entirely to electric subway and elevated railways. The efficiency of these stops has been satisfactorily demonstrated in such protected locations where they are not subject to the effects of heavy snow and frost and possible tampering by trespassers and where a very high maintenance and inspection cost is warranted by the dense traffic. The board does not consider the experience gained under these conditions, however, to be conclusive as to their efficiency in unprotected locations. In the existing installations of automatic stops, the assumption has been that the motorman would properly control the movement of his train in accordance with the signal indications and the automatic stop is only intended to come into play when for any cause the motorman is incapacitated; in this respect it has precisely the same function as the "dead man" on the controller handle. Motormen do not ordinarily have a companion in the cab as does the engineman of a steam locomotive and for this reason there is perhaps a stronger argument for the introduction of such devices on electric railways than on steam railways.

The object of a cab signal is entirely different from that of an automatic stop, though the two devices have been combined in most of the plans submitted by inventors to the board, since it is a simple matter to actuate a stop mechanism with the same control used for the cab signal. Cab signals are intended primarily to give a prominent warning close at hand to the engineman or motorman of a dangerous condition of track ahead. If the warning is not heeded the stop comes into play. There are arguments for and against the use of cab signals. In bad weather when fixed visual signals alongside of the track may be obscured by snow or fog, an indication in the cab cannot be missed or mistaken. Under any conditions, the indications of a cab signal are more likely to be impressed on the mind of the motorman or engineman than those of an exterior fixed signal. They can be made to give both visible and audible warnings and are easily combined with an automatic stop mechanism. On the other hand, the place for the motorman to center his attention is on the track ahead. A cab signal is a temptation to close the windows and trust to the signal inside, which is not absolutely infallible. If the signal apparatus on a

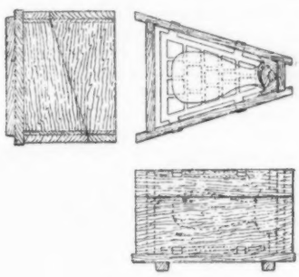


FIG. 11.

motor car or locomotive gets out of order and there are no fixed signals along the road the car or train must proceed under the protection of a flagman ahead. Cab-signal apparatus must be constructed on the same principles as any other signal mechanism, namely, that a failure of any part will result in a danger signal and not a false clear signal. One reason for rejecting many of the plans submitted to the board was that the inventors had violated this principle by using a normally open circuit. With an open circuit a failure of any part of the apparatus cannot be detected by a distinctive indication of the signal and may exist as a source of danger for a long time.

The use of "wireless" communication between the controlling circuit and the apparatus on the car is an interesting characteristic of an experimental installation of cab signals and automatic stops on the line of the Suburban Railroad Company in the outskirts of Chicago. A coherer is made part of a closed circuit on the car and this circuit is broken, giving a danger indication on the cab signal if the particles in the coherer cease to be held in contact by the effect of the Hertzian waves emanating from a continuous-line wire strung along the track.

In referring to the merits of automatic stops and cab signals the report of the board states that in Great Britain the cab signal is considered only as a convenience, while "in America, both cab signals and automatic stops have been proposed as safety devices purely on the assumption that the vigilance of enginemen and motormen cannot be improved to the point of insuring a satisfactory degree of safety while using only the present visual signals."

Elsewhere in the report also, the authors refer to the evidently greater efficiency of British railway employees as compared with the men employed in similar positions by the railways of the United States.

The report concludes with a strong indorsement of

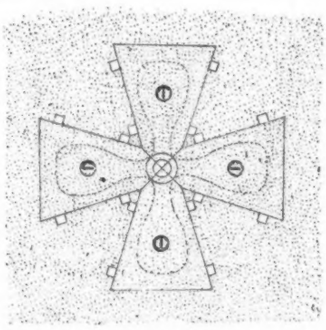


FIG. 12.

telephone train dispatching as against telegraph dispatching with the Morse code. Several steam roads have adopted telephones for train dispatching during the past two years and their experience has been that telephones are as safe and convenient as the Morse-code telegraph. The contingent liability of indistinct or incorrect transmission of words and figures must be guarded against in both systems of communication by good training, discipline and by repeating back all messages.—Electric Railway Journal.

EDISON'S INVENTIONS.—II.

THEIR COMMERCIAL VALUE TO THE WORLD.

BY FRANK L. DYER AND T. COMMERFORD MARTIN.

Concluded from Supplement No. 1735, page 211.

THE manufacture of the projecting machines and accessories, together with the reproduction of films, is carried on at the Orange Valley plant, and from the inception of the moving-picture business to the present time there have been made upward of 13,100 projecting machines and many million feet of film carrying small photographs of moving objects. Although the moving-picture business, as a commercial enterprise, is still in its youth, it is of sufficient moment to call for the annual production of thousands of machines and many million feet of films in Mr. Edison's

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Thomas A Edison

shops, having a sale value of not less than $750,000. To produce the originals from which these Edison films are made, there have been established two "studios," the largest of which is in the Bronx, New York city, and consists of a large theater practically all of glass, adjoining which is a commodious four-story concrete building containing offices, dressing rooms, and photographic and developing laboratories. A large corps, comprising actors, actresses, dancers, acrobats, scene painters, scene shifters, property men, photographers, stage managers, and others, is kept constantly and busily employed at these two studios every day in producing the negatives of new motion pictures that are subsequently reproduced, as positives, in large numbers and shipped to all parts of the country.

In this, as well as in the phonograph business, there are many other manufacturers in the field. Indeed, the annual product of the Edison Manufacturing Company in this line is only a fractional part of the total that is absorbed by the 10,000 or more moving-picture theaters and exhibitions that are in operation in the United States at the present time, and which represent an investment of some $40,000,000. Licensees under Edison patents in this country alone produce upward of 60,000,000 feet of films, containing more than a billion and a half separate photographs. To what extent the moving-picture business may grow in the not remote future it is impossible to conjecture, for it has taken a place in the front rank of rapidly increasing enterprises.

The manufacture and sale of the Edison-Lalande primary battery, conducted by the Edison Manufacturing Company at the Orange Valley plant, is a business of no mean importance. Beginning about twenty years ago with a battery that would furnish large currents without polarizing, specially adapted for gas-engine ignition and other important purposes, the business has steadily grown in magnitude until the present output amounts to about 125,000 cells annually; the total number of cells put into the hands of the public up to date being approximately 1,500,000. It will be readily conceded that to most men this alone would be an enterprise of a life-time, and sufficient in itself to satisfy a moderate ambition. But, although it has yielded a considerable profit to Mr. Edison and gives employment to many people, it is only one of the many smaller enterprises that owes its existence to his inventive ability and commercial activity.

So it also is in regard to the mimeograph, whose forerunner, the electric pen, was born of Mr. Edison's brain in 1877. He had been long impressed by the desirability of the rapid production of copies of written documents, and, as we have seen by a previous chapter, he invented the electric pen for this purpose, only to improve upon it later with a more desirable device which he called the mimeograph, that is in use, in various forms, at this time. Although the electric pen had a large sale and use in its time, the statistics relating to it are not available, nor possibly, might it be desirable to give them if they were, for the present object of the writers is to show the commercial value which the world of to-day places upon Mr. Edison's inventions. The mimeograph, however, is, and has been for many years, a standard office appliance, and is entitled to consideration, as the total number put into use up to this time is approximately 180,000, valued at $3,500,000, while the annual output is in the neighborhood of 9,000 machines, sold for about $150,000, besides the vast quantity of special paper and supplies which its use entails in the production of the many millions of *fac-simile* letters and documents called into being annually through its operation. The extent of production and sale of supplies for the mimeograph may be appreciated, when it is stated that they bring annually an equivalent of three times the amount realized from sales of machines. The manufacture and sale of the mimeograph does not come within the enterprises conducted under Mr. Edison's personal direction, as he sold out the whole thing some years ago to Mr. A. B. Dick of Chicago.

In making a somewhat radical change of subject, from duplicating machines to cement, we find ourselves in a field in which Mr. Edison has made a most decided impression. The reader has already learned that his entry into this field was, in a manner, accidental, although logically in line with pronounced convictions of many years' standing, and following up the fund of knowledge gained in the magnetic ore-milling business. From a newcomer into the cement business, his corporation in five years has grown to be the fourth largest producer in the United States, with a still increasing capacity. From the inception of this business there has been a steady and rapid development resulting in the production of a grand total of over 5,000,000 barrels of cement up to the present date, having a value of about $4,500,000, exclusive of package. At the time of this writing, the rate of production is over 8,000 barrels of cement per day, or say 2,500,000 barrels per year, having an approximate selling value of a little less than $2,000,000, with prospects of increasing in the near future to a daily output of 10,000 barrels. This enterprise is carried on by a corporation called the Edison Portland Cement Company, in which he is very largely interested, and of which he is the active head and guiding spirit.

Had not Mr. Edison suspended the manufacture and sale of his storage battery a few years ago because he was not satisfied with it, there might have been given here some surprising figures of an extensive business, for the company's books show an astonishing number of orders that have been received during that time. He has been implored for batteries, but in spite of the fact that good results have been obtained from the 18,000 or 20,000 cells sold some years ago, and still in use, he has adhered firmly to his determination to perfect them to a still higher standard before resuming and continuing their manufacture as a regular commodity. The time is almost at hand when this consummation will be reached, and then another Edison industry will resume where it once left off, and without doubt will grow into great prominence.

Thus far in our statistics we have concerned ourselves chiefly with those figures which exhibit the extent of investment and production, but there is another and humanly important side that presents itself for consideration, namely, the employment of a vast industrial army of men and women, who earn a living through their connection with some of the arts and industries to which our narrative has direct reference. To this the reader's attention will now be drawn.

The following figures are based upon the Special Reports of the Census Bureau, 1902 and 1907, with additions computed upon the increase that has subsequently taken place. It will be quite sufficient for the purpose to give averages only, and those in round numbers, as in no business of any magnitude does the number of employees remain constant. It is the intention of the writers, however, to remain well within the mark in offering these statistics, as the figures will thus be sufficiently extensive without the slightest exaggeration. In the totals following is included the compensation paid to salaried officials and clerks. Details relating to telegraph systems are purposely omitted, for reasons above given.

Taking the electric light into consideration first, we find that in the central stations of the United States there are not less than an average of 45,000 persons employed, requiring an aggregate yearly payroll of over $35,000,000. This does not include the 100,000 or more isolated electric light plants scattered throughout the land. Many of these are quite large, and at least one-third of them require one additional helper, thus

* From the forthcoming "Life of Edison." Copyright, 1908, by Harper & Bros.

adding, say, 33,000 employees to the number already mentioned. If we assume as low a wage as $10 per week for each of these helpers, we must add to the foregoing an additional sum of over $17,000,000 paid annually for wages, almost entirely in the isolated incandescent electric lighting field.

Central stations and isolated plants consume over 150,000,000 incandescent electric lamps annually, and in the production of these there are engaged about 40 factories, on whose payrolls appear an average of 14,000 employees, earning an aggregate yearly sum of $8,000,000.

Following the incandescent lamps we must not forget an industry exclusively arising from it and absolutely dependent upon it, namely, that of making fixtures for such lamps, the manufacture of which gives employment to upward of 6,000 persons, who annually receive at least $3,750,000 in compensation.

The detail devices of the incandescent electric lighting system also contribute a large quota to the country's wealth in the millions of dollars paid out in salaries and wages to many thousands of persons who are engaged in their manufacture.

The electric railways of our country show even more astounding figures than the lighting stations and plants, as they employ on the average over 250,000 persons, whose annual compensation amounts to not less than $155,000,000.

In the manufacture of about $50,000,000 worth of dynamos and motors annually, for central station equipment, isolated plants, electric railways, and other purposes, the manufacturers of the country employ an average of not less than 30,000 people, whose yearly pay roll amounts to no less a sum than $20,000,000.

The growth of the telephone systems of the United States also furnishes us with statistics of an amazing nature, for we find that the average number of employees engaged in this industry is at least 140,000, whose annual earnings aggregate a minimum of $75,000,000; besides which the manufacturers of telephone apparatus employ over 12,000 persons, to whom is paid annually about $5,500,000.

No attempt is made to include figures of collateral industries, such, for instance, as copper, which is very closely allied with the electrical arts, and the great bulk of which is refined electrically, the intention being not purely statistical, but merely to indicate in a general way the growth and present importance to the world that these erstwhile infant inventions have assumed in less than the period of one generation.

The 10,000 or so moving-picture theaters of the country employ no fewer than 75,000 people, whose aggregate annual income amounts to not less than the immense sum of $37,500,000.

Coming now to the Orange Valley plant, we take a drop from these magnificent figures to the comparatively modest ones which give us an average of 3,600 employees and calling for an annual pay roll of about $2,250,000. It must be remembered, however, that the great sums mentioned above represent industries operated by great aggregations of capital, while the Orange Valley plant, as well as the Edison Portland Cement Company, with an average daily number of 530 employees and over $400,000 annual pay roll, represent in a large measure an industry that is more in the nature of a closely held enterprise and practically under the direction of one mind.

The table herewith given summarizes the figures that have just been presented, and gives an idea of the gigantic totals affected by the genius of this one man. It is well known that many other men and many other inventions have been needed for the perfection of these arts; but it is equally true that, as already noted, some of these industries are directly the creation of Edison, while in every one of the rest his impress has been deep and significant. Before he began inventing, only two of them were known at all as arts—telegraphy and the manufacture of cement. Moreover, these figures deal only with the United States, and take no account of the vast development of many of the Edison inventions in Europe or of their adoption throughout the world at large. Let it suffice that in America alone, the work of Edison has been one of the most potent factors in bringing into existence new industries now capitalized at over $7,000,000,000, earning annually over $1,000,000,000, and giving employment to an army of more than half a million of people.

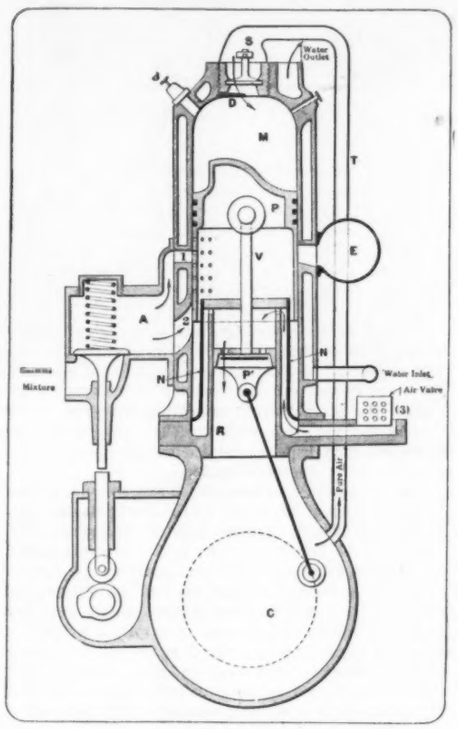
STATISTICAL RESUMÉ (APPROXIMATE) OF SOME OF THE INDUSTRIES IN THE UNITED STATES DIRECTLY FOUNDED UPON OR AFFECTED BY INVENTIONS OF THOMAS A. EDISON.

Class of Industry.	Investment.	Annual Gross Revenue or Sales.	Number of Employees.	Annual Pay Rolls.
Central station lighting and power	$1,000,000,000	$225,000,000	50,000	$40,000,000
Isolated incandescent lighting	500,000,000	——	33,000	17,000,000
Incandescent lamps	25,000,000	20,000,000	14,000	8,000,000
Electric fixtures	8,000,000	5,000,000	6,000	3,750,000
Dynamos and motors	60,000,000	50,000,000	9,000	20,000,000
Electric railways	4,000,000,000	450,000,000	250,000	155,000,000
Telephone systems	800,000,000	175,000,000	140,000	75,000,000
Telephone apparatus	30,000,000	15,000,000	12,000	5,500,000
Phonograph and moving pictures	10,000,000	15,000,000	5,000	6,000,000
Moving picture theaters	40,000,000	80,000,000	75,000	37,000,000
Edison Portland cement	4,000,000	2,000,000	530	400,000
Telegraphy	250,000,000	60,000,000	100,000	30,000,000

The reader may have noticed in a perusal of this chapter the lack of autobiographical quotations, such as have appeared in other parts of this narrative. Mr. Edison's sense of modesty has allowed us but one remark on the subject. This was made by him to one of the writers a short time ago, when after an interesting indulgence in reminiscences of old times and early inventions, he leaned back in his chair and with a smile on his face said, "Say, I *have* been mixed up in a whole lot of things, haven't I?"

The services which can be, and to some extent have been, rendered in war by dogs, in searching for the wounded on battlefields, and conveying them to the ambulances, have been frequently described. In France a society, called the Société Nationale du Chien Sanitaire, has been formed for the purpose of introducing this valuable auxiliary into the sanitary service of the country.

So, in presenting the mass of statistics contained in this chapter, we fear that the result may have been the bewilderment of the reader to some extent. Nevertheless, in writing a biography of Mr. Edison, the main object is to present the facts as they are, and leave it to the intelligent reader to classify, apply, and analyze them in such manner as appeals most forcibly to his intellectual processes. If in the foregoing pages there has appeared to be a tendency to attribute to Mr. Edison the entire credit for the marvelous state of growth to which many of the above-named great enterprises have in these latter days attained, we must especially disclaim any intention of giving rise to such a deduction. No one who has carefully followed the course of this narrative from its beginning can deny,



COLMANT TWO-CYCLE MOTOR.

however, that Mr. Edison is the father of some of the arts and industries that have been mentioned, and that as to some of the others it was the magic of his touch that helped make them practicable. Not only to his work and ingenuity is due the present magnitude of these arts and industries, but also to the splendid work and numerous contributions of other great inventors, such as Brush, Bell, Elihu Thomson, Weston, Sprague, and many others, as well as the financiers and investors, who in the past thirty years have furnished the vast sums of money that were necessary to exploit and push forward these enterprises, that have added so enormously to the wealth and progress of the country and to the comfort and convenience of its citizens.

A NEW TWO-CYCLE MOTOR.

By our PARIS CORRESPONDENT.

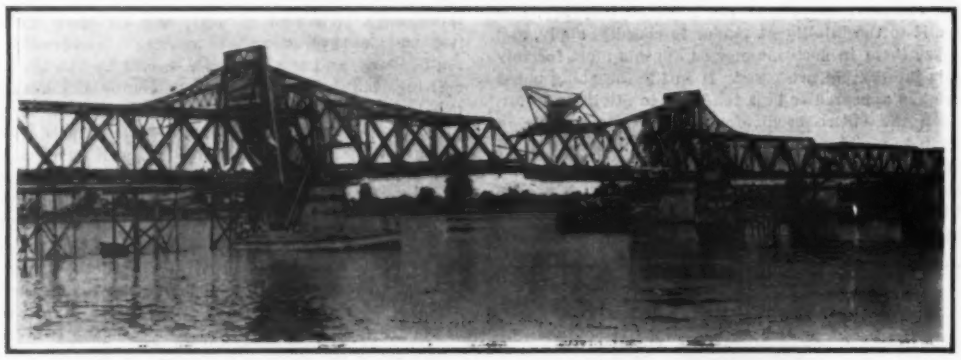
THE new Colmant two-cycle motor was tested recently at the laboratory of the Automobile Club of France. This motor is characterized by the direct method of cooling the inner walls of the cylinder and the piston head by means of a circulation of air which is produced by a pump independent of the pump used for the charge of fresh gas, and this in addition to the method of cooling by water jacket in the usual way, or by an air draft. The first motor of the kind which was tested is described below. The inlet to the cylinder is carried out by a large-diameter cam-operated valve placed at the top of the cylinder beside the air-cooling valve, and the exhaust takes place by the two openings of very large size which are systematically placed at the end of the stroke. The motor has but a small plant efficiency, which is below that of a four-cycle motor of the same bore and stroke, 100 x 120 millimeters (3.94 x 4.7 inches), and its speed is limited to 850 revolutions per minute. It works in a regular way and can be easily varied by the ignition shifting, but is less easy to control by the gas-inlet openings. The gas inlet from a carbureter of the usual kind is made at *A* by a cam-operated valve. When the main motor piston *P* rises, it gives a suction for the next charge of gas in the annular space *N*. This latter space is between the air-pump cylinder *R* having the lower piston P^1 and the motor cylinder. In order to lower the resistances of this suction, the valve-chamber *A* communicates with the spaces *N* and *V* by two openings 1 and 2, and the piston carries a set of 10 millimeter (0.39 inch) holes in the part of the periphery which corresponds to the two openings. When the piston descends it drives this charge by the same two openings into the valve-chamber *A*, whose dimensions are such that the tension of the gas does not exceed 0.600 gramme. The cam-operated valve opens at the lower dead point of the motor and is closed 17 deg. after the upper dead point. In descending, the piston first uncovers the exhaust and then the conduit 1 of the inlet to the cylinder, and the admission takes places as in all two-cycle motors of this kind. But here this charge, instead of being obliged to drive the burned and hot gases in front of it, meets at this moment only cold air in the cylinder (theoretically) and it expels this air through the exhaust so as to take its place. What characterizes the present motor is that the lower piston P^1 forms the piston of an air-pump and the air is driven into the crank-box by each combined descent of the two pistons, these being rigidly connected together. This pure air coming from the outside has been drawn in by the piston P^1 at its upper face. The latter piston carries a valve which is made very simply of a thin disk of steel which is closed at the descent and opened at the rise of the piston, and this without the use of a spring. The air follows the paths which are indicated by the arrows, and it is easy to see that the tension is a maximum in the crank-case when the motor piston *P* arrives at about the lower dead point. However, the exhaust commences at this time with a strong effect, and it is at this period that the automatic valve *S* at the top of the cylinder will work under the sole influence of the suction caused in the cylinder by the quick outrush of burned gas. But the valve *S* is connected to the crank-case by a tube *T*. The pressure in *C* and the suction in *M* are added, and a strong air current arrives from *C* to *M*, cooling the sides of the cylinder and the piston-head. By its force and also by mixing it quenches the still burning (or at least very hot) gas and drives it out in order to take its place. This mixture is encountered by the new charge and the latter expels it altogether if the carbureter air supply gives a whole cylinderful of gas, or in part if the cylinder is only partly supplied with fresh gas. But in either case at half or at full load, the piston *P* in remounting always finds a complete cylinderful of gas to compress, and in the two cases the motor works at a total compression of 5.800 kilogrammes (12.787 pounds) per square centimeter (0.155 square inch). By closing the inlet we soon reduce the quality of the mixture, which is finally compressed, but we do not reduce the rate of compression. This will hold good as long as we have not reduced the inlet to such point that the two cylinder capacities (air pump and gas pump added together) are inferior to the volume given by the piston as far as *M*.

It is announced from Ottawa that a commission has, on behalf of the Canadian Pacific Railway, been investigating the water-power resources of the Rocky Mountains, and has come to the conclusion that, although immense quantities of coal are available, electricity can be used to better advantage in overcoming the heavy mountain gradients, on account of the greater cheapness and superior climbing capacities of the electric locomotives. Electrification, it is said, will at first be confined to the mountain section of the Canadian Pacific line, though enough water-power is available to work the whole system in this manner.

A ROLLING LIFT BRIDGE IN BURMA.

AN AMERICAN BRIDGE FOR THE FAR EAST.

In August, 1904, the Burma Railways Company commenced work on an extension of their lines from Henzada to Kyangin. This work necessitated the construction of a bridge to cross the Ngawun River about sixteen miles from Henzada. It was originally intended to construct this bridge of fixed spans, the approaches to be graded so as to provide a clearance of 40 feet underneath the bridge for the passage of vessels. As this clearance required a grade of 1:200, it was decided to reduce the grade to 1:300, and to construct a movable bridge for the accommodation of navigation.



BOTH LEAVES COUNTERBALANCED AND OPERATED TO THEIR CLOSED POSITIONS WHEN NEARING COMPLETION.

Extensive navigation is carried on along the Ngawun River by the Irrawaddy Flotilla Company, which operates a line of steamers for both freight and passenger traffic. For the accommodation of the navigation interests, the government authorities required a clear channel of 200 feet, which, with the local conditions to be met, caused a careful consideration to be given as to the most suitable type of movable bridge. A double-leaf through rolling lift bridge was selected as being the most desirable structure to fulfill all the conditions, and arrangements were made with the Scherzer Rolling Lift Bridge Company of Chicago for designs, plans, and specifications.

The bridge was fabricated at the works of Messrs. Spencer & Co., Melksham, Wiltshire, England, and was shipped by them to Burma after having first been erected temporarily at their works.

The superstructure consists of a double-leaf, through, single-track Scherzer rolling lift bridge, having a span of 220 feet center to center of bearings, flanked on each side by a through-truss approach span of 160 feet; with one additional approach span on one side, and two on the other of about the same span length. The substructure consists of brick masonry piers founded on wells, the type of construction generally used in India and Burma. The design of the bridge was based on the specifications of the government of India for railway bridges.

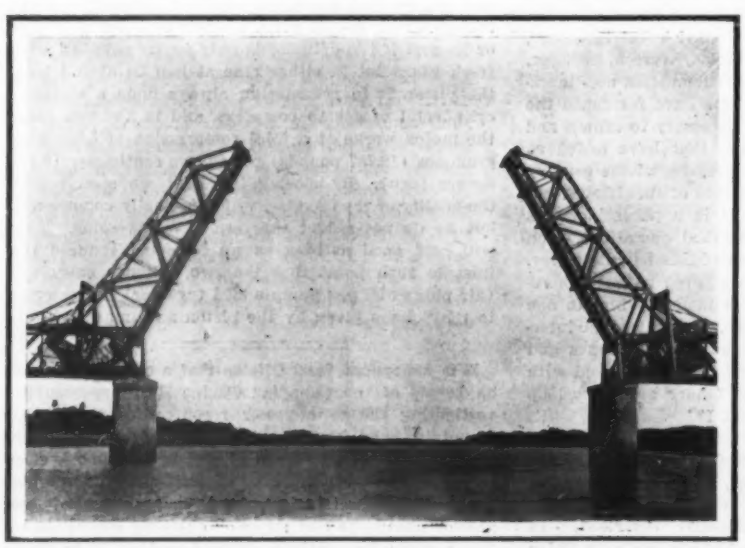
The superstructure of the fixed spans was erected on false work composed of frame bents resting on piles, there being four towers of two bents each for each approach span. The leaves of the bascule span were erected in the open position by means of a sliding derrick, which was raised on the open leaf as each panel was added.

The track girders on which the moving leaves roll in opening and closing are carried by the adjacent fixed spans, eliminating the piers usually provided to support the rear ends of the track girders. One of the characteristics of the design is the economical arrangement and the small size of the piers. They provide ample support for the superstructure with the least possible obstruction to the flow of water. The rivers in India and Burma during the rainy season are subjected to heavy floods, and obstructions to the flow of the water cause deep holes in the river bed, necessitating great care in foundation design. The great advantage of the bascule bridge over the old-fashioned type of swing bridge in this respect is apparent from a study of the general plan of this structure.

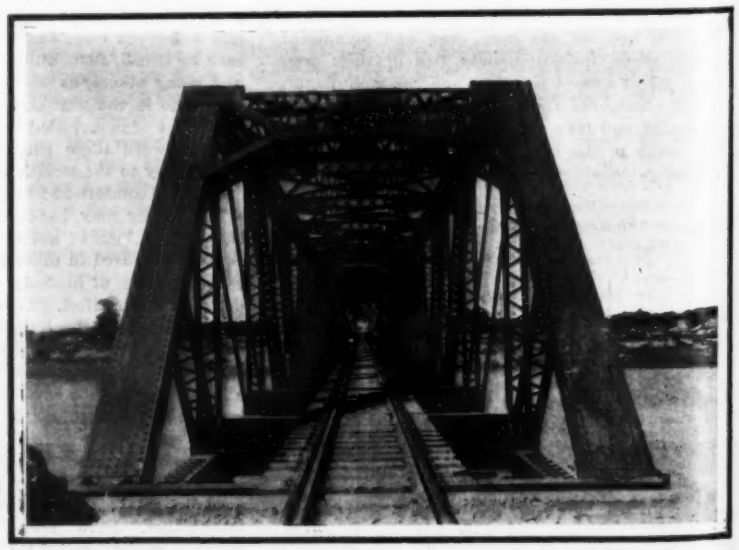
The bridge is operated by hand power from winches on the deck of the approaches, transmitted by a system of gearing to the main operating struts, of which there are two on each leaf outside of the trusses, the center line of the struts coinciding with the center line of the approach trusses. The two winches for operating each leaf are located on platforms on the outside of the approach spans.

The substructure was completed and erection started in the spring of 1908, the bridge being finally completed and opened to traffic early in December, 1908.

This is the largest movable bridge yet constructed in Asia, and its successful and satisfactory completion will undoubtedly lead to the construction of others bridges of this type where similar problems are to be solved. By the use of a rolling lift bridge the base of rail can be placed a minimum distance above water, effecting a large saving as compared with the cost of a fixed bridge elevated a sufficient height above the water to allow the passage of vessels underneath the bridge, in which case long and high embankments would have to be constructed to reach the bridge level. The grades would be a perpetual tax on all traffic crossing the bridge. The broad-minded solution of this problem by the officials of the railway company and the permanent character of the construction are another evidence of the great works being carried on by the British government for the progress and welfare of India.



THE TWO LEAVES FORMING THE MOVABLE SPAN COMPLETED AND IN PARTLY OPEN POSITION.



END VIEW ON LINE OF TRACKS. VIEW FROM THE SOUTH ABUTMENT.

A ROLLING LIFT BRIDGE ACROSS NGAWUN RIVER, BURMA.

ENAMELS FOR IRON.

GREAT progress has recently been made in the art of enameling metals, and many new processes have been patented.

Iron must first receive a counter-enamel, or underglaze, to protect the enamel—especially if this is white—from the reducing action of the carbon contained in the iron.

The first underglaze was composed of a frit of quartz and borax, mixed with additional quartz and a little clay. This mixture does not adhere firmly to sheet iron, for it is merely vitrified but not completely fused. This defect has been remedied by the addition of oxides. The following is a good formula for an underglaze for sheet iron:

	Parts by Weight.		Parts by Weight.
Quartz	17	Saltpeter	2
Felspar	30	Oxide of cobalt	0.18
Borax	46	Oxide of nickel	0.42
Carbonate of soda	2	Oxide of copper	0.03
Fluosilicate of soda	3		

To the mixture, after fusion, 7 per cent of clay is added and thoroughly incorporated with it by rubbing.

The composition of the white enamel has also been improved by the substitution of fluorides for part of the oxide of tin. An old formula for white enamel contains:

	Parts by Weight.		Parts by Weight.
Silica	37	Carbonate of ammonia	7.5
Borax	37.5	Magnesia	5
Carbonate of soda	15	Oxide of tin	30
Saltpeter	10		

The following is a modern formula for white enamel:

	Parts by Weight.		Parts by Weight.
Quartz	10.5	Cryolite	12
Felspar	37.5	Saltpeter	0.7
Borax	18		

Cryolite (natural or artificial) is a double fluoride of aluminium and sodium.

Eight per cent of oxide of tin and 7 per cent of clay are ground with the fused mixture.

A few establishments produce a white enamel on cast iron with the aid of the underglaze given above. The process can be applied only to cast iron which contains comparatively little carbon.

A good enamel for cast iron is composed of:

	Parts by Weight.		Parts by Weight.
Quartz	13	Minium	17.4
Felspar	26	Limestone	2
Boric acid	14.4	Magnesia	2
Carbonate of soda	4.7	Cryolite	11
Saltpeter	4.3	Flouride of calcium	0.02

To the fused mass are added 7 per cent of oxide of tin and 7 per cent of clay.

THE COMMERCIAL PRODUCTION OF OXYGEN.

THE IMPROVED CLAUDE PROCESS.

BY DR. ALFRED GRADENWITZ.

THE European oxygen industry is passing through a period of most remarkable development. Oxygen factories are springing up everywhere to produce this valuable gas, which especially in metallurgy is now utilized for many purposes. This fact is due in a large part to the great improvements that have taken place during the last few years in the methods of liquefying air and separating it into its constituents, oxygen and nitrogen. The process due to Prof. Linde, the celebrated scientist of Munich, Bavaria—which is based on the expansion of compressed air and the production of internal work during expansion through a constricted orifice—is fairly well known in this country. In order to obtain oxygen, Prof. Linde liquefies completely some atmospheric air, so as to produce a liquid containing 21 per cent of oxygen, which is then caused to flow down a rectifying column similar to those used in distilling alcohol or gasoline. In this column the liquid meets with oxygen vapors resulting from the liquid oxygen, which is vaporized by the latent heat of the air in course of liquefaction; in this way a pure commercial oxygen (96 to 98 per cent) is eventually obtained, while the nitrogen produced at the same time still contains at least 7 per cent of oxygen, that is, one-third of the oxygen of air.

Although giving better results, Claude's process is not perhaps so well known outside of the Continent because of its more recent origin. It is worked in France by L'Air Liquidé, Ltd., at Paris, Lyons, Marseilles, and in Belgium at Dugrée near Liège, while in October new works will be opened in Italy and Germany.

In the Claude process for the liquefaction of air, the expansion of compressed air with the production of recoverable external work is made use of, that is, expansion takes place on the piston of a reciprocating engine. Though this method, according to theory, gives far better yields than that of expansion through a valve, many scientists previous to Claude (such as Siemens, Solvay, Hampson) in vain endeavored to carry out the expansion of compressed air is an engine, and Linde even believed it to be utterly impossible.

There was, in fact, one great difficulty to be overcome in this connection, viz., the lubrication of an engine at such low temperatures that all lubricating substances would have become frozen. Claude succeeded in eliminating this difficulty by using light petroleum ethers, which at ordinary temperatures are not lubricants, but acquire lubricating properties as the temperature is getting very low. Claude's first successful experiments were officially announced to the French Academy in 1902 by the well-known physicist, Prof. d'Arsonval.

THE OXYGEN CYLINDER STOREROOM.

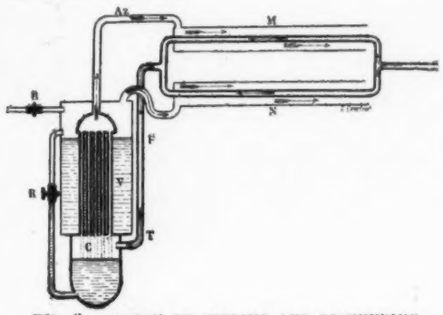


FIG. 3.—SYSTEM OF COOLING AND LIQUEFYING COMPRESSED AIR.

In Claude's original machine (see Fig. 1) the compressed air was cooled in the inner tube of the exchanger *M*, in order then to be expanded in the engine *D*, the liquefied portion being collected at the end of the expansion in the receptacle *R*, while the unliquefied portion was allowed to flow through the outer tube *B* of the exchanger *M*, thus cooling the incoming compressed air.

It is true that this original system failed to give really satisfactory results, because of the many difficulties arising from the liquefaction taking place in the cylinder itself; as moreover liquefaction is effected at —190 deg. C. (—310 deg. F.) at the end of expansion and under atmospheric pressure, the air in this condition, after traversing the exchanger, reaches the engine at about —135 deg. C. (—211 deg. F.), at which temperature it no longer obeys Boyle's law, but contracts much more than would correspond to the latter. A considerable excess of air should therefore be thrown into the engine, in order actually to produce an amount of cold as corresponding to theoretical calculation.

This drawback is greatly diminished by raising the

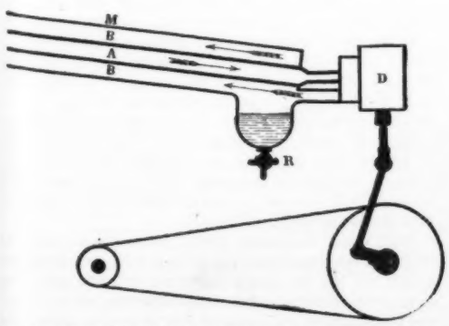


FIG. 1.—SYSTEM OF COOLING INCOMING COMPRESSED AIR.

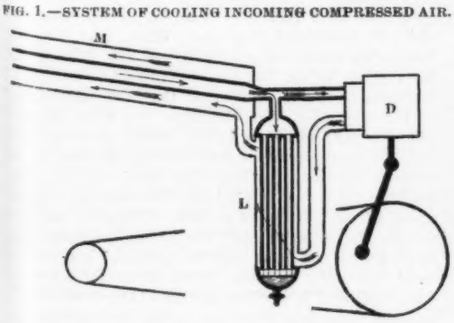


FIG. 2.—PROCESS OF LIQUEFACTION UNDER PRESSURE.

WORKSHOP WHERE OXYGEN APPARATUS ARE CONSTRUCTED.

THE IMPROVED CLAUDE PROCESS FOR PRODUCING OXYGEN.

initial temperature of expansion from —135 deg. C. (—211 deg. F.) to —100 deg. C. (—148 deg. F.); and in order to achieve this result, Claude interposes between the temperature exchanger and the expansion engine an apparatus *L* called "liquefactor," into which part of the compressed air is thrown after its passage through the exchanger (Fig. 2).

The air in *L* being under a pressure of about 40 atmospheres will not liquefy as in Fig. 1 at —190 deg. C. (—310 deg. F.), but at — 140 deg. C. (—220 deg. F.), which is the critical temperature of air. The air expanded in the engine accordingly is first heated in *L* up to —140 deg. C. (—220 deg. F.), before entering the exchanger *M*, instead of being at a temperature of —190 deg. C. (—310 deg. F.), as in the original apparatus. The air admitted into the engine thus is at a somewhat higher temperature. This liquefying process, which is called by the inventor "liquefaction under pressure," can yield one liter of liquid air for each horse-power-hour.

This remarkable process seems to have been recently imitated by several constructors, such as, e. g., an engineer of the New England Refrigerating Company, of Norwich, Mr. Place, who in describing this process as his own, states that:

"The cold exhaust air from the engine is carried over pipes containing air to be liquefied (in an opposite direction thereto) which is at a higher pressure of 600 pounds; this exhaust air is then carried back over the incoming compressed air being supplied to the engine, and cools that cold air . . ." In fact, this process is identical with the one indicated by Claude in 1902.

In order then to separate the oxygen from the nitrogen, Claude uses a method based on the partial liquefaction of air. Although so competent an authority as Sir J. Dewar emphatically denied the impossibility of partially liquefying air, maintaining that the oxygen would come down together with the whole of the nitrogen, Claude succeeded in experimentally demonstrating that his idea could very well be carried out into practice, a liquid rich in oxygen being at first given out from air. In Claude's process, this partial liquefaction is combined with what is called the "backward return" of the liquid portions, this additional factor being necessary to allow of a satisfactory separation of the air in course of liquefaction.

In Fig. 3 the compressed air cooled in the exchangers *M* and *N*, after entering the apparatus in *T*, is liquefied gradually in the set of tubes *F* surrounded by liquid air, the first drops containing about 48 per cent of oxygen.

While the remaining gas, which is a little poorer in oxygen than air, rises higher up in the tubes, a liquid comes off containing less than 48 per cent of oxygen. However, as soon as some liquid is produced in the tubes, it, owing to its weight, returns backward in an opposite direction to the ascending gases and in contact with them, so that part of the oxygen of those gases is liquefied, replacing a corresponding amount of liquid nitrogen, which is vaporized.

The same process is repeated throughout the length of the tubes, and allows a liquid to be obtained holding 48 per cent of oxygen and comprising the whole of the oxygen of the air, leaving on the other hand pure gaseous nitrogen.

In spite of these remarkable results, the partial liquefaction conducted under the conditions described still proved inadequate for manufacturing pure oxygen. The latter was obtained only by combining the principle of liquefaction as above described with the rectifying process used for many years in the distilling industries.

Fig. 4 shows the apparatus constructed for this purpose. The cold compressed air at *A* enters the tubes *F*, and is partially liquefied in the latter. The liquid thus formed returns in an opposite direction to the ascending gases, and finally yields a liquid containing about 48 per cent of oxygen, while pure gaseous nitrogen comes out at the top of the tubes *F*, in order then to be liquefied in the tubes *F'*. The liquid rich in oxygen collected at *C*, owing to its pressure, is poured out in the central part of the column, and rectifies the ascending gases up to a percentage of 21 per cent, while the liquid nitrogen collected at *C'* is poured out from the top of the column, and submits the gases at 21 per cent to a further rectification.

After having been washed by pure liquid nitrogen, the gas finally becomes itself pure nitrogen gas, coming out of the apparatus at *E*.

The pure oxygen resulting from rectification at the bottom of the column is vaporized at *V*, the greater part of it entering the column of rectification, while the remainder comes out at *T* and is then collected.

By this means an integral separation of atmospheric air into its constituents, pure oxygen and pure nitrogen, is carried out.

The large illustrations represent a plant able to turn out each hour as much as 50 cubic meters (1,776 cubic feet) of oxygen, the air expander being seen at the left; the oxygen-cylinder store; and the workshop where M. Claude's apparatus are constructed.

THE ELECTRICAL PROPERTIES OF FLAMES.

THE discourse at the Royal Institution, delivered by Prof. Harold A. Wilson, D.Sc., F.R.S., of King's College, London, on "The Electrical Properties of Flames," is thus summarized by Engineering:

The conductor plate of an electrometer, Prof. Wilson showed, was quickly discharged, when the flame of

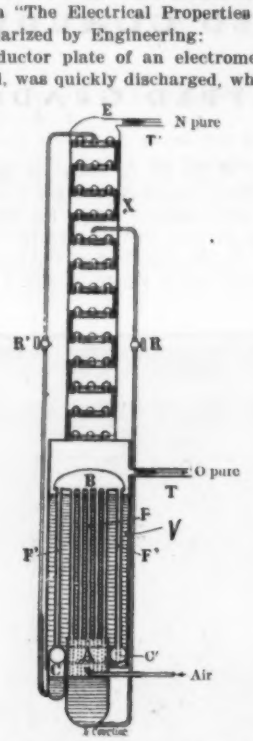
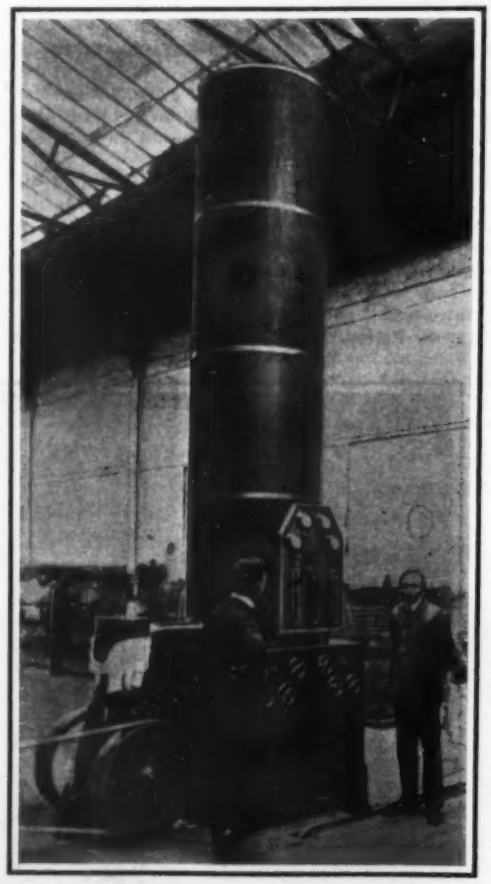


FIG. 4.—APPARATUS FOR SEPARATING ATMOSPHERIC AIR INTO PURE OXYGEN AND NITROGEN.

a Bunsen burner was held near it, and less rapidly when held a few inches above it. The gases in the flame were supposed to be split into positive and negative ions, and a positively charged conductor might become discharged either by letting its positive electricity escape, or by attracting the negative particles in the flame. That the latter was the correct explanation was proved by placing a plate of mica on the charged conductor. That had no direct effect. When the flame was approached, the electrometer pointer



THE APPARATUS FOR THE PRODUCTION OF OXYGEN.

THE IMPROVED CLAUDE PROCESS FOR PRODUCING OXYGEN.

went slowly down, as if part of the charge really had escaped; but when the mica was taken off, the electrometer rose again, showing that the mica acted as a condenser; the ions were still attracted through the mica, but were stopped on the surface of the mica. On replacing the mica on the conductor the electrometer went down again.

That the ions rose up with the stream of hot gas from the flame was demonstrated in the next experiment. Within a vertical tube three insulated metal cylinders were fixed along the axis, the cylinders being at some little distance apart. From each cylinder there projected through an insulated sleeve in the side of the tube a bent wire, from which a pith ball was suspended. The three cylinders were electrically charged. When a burning spirit lamp was placed under the tube, the bottom cylinder was quickly discharged, and then, more slowly, the middle cylinder, and the top cylinder still more slowly. That experiment demonstrated that most of the ions were consumed in discharging the first cylinder, and moreover, that they recombined and lost their mobility as the gas cooled. In the third experiment an induction coil had two spark gaps, an ordinary cold-air gap and two Bunsen flames, and it resulted that the discharge preferred to bridge a long burner gap, traveling up one flame, then sparking across to the other from tip to tip, and going down the other flame, rather than jump a short gap in cold air. Here the few ions produced in the flame were not sufficient to carry the powerful spark discharge, and the applied potential had itself to ionize the air. The effect really depended, in this case, upon the density of the air. The hot-gas gap was about seven times as long as the cold-air gap, and the same potential also sent a spark through a bulb seven times as long as the cold gap, but filled with air of one-seventh the ordinary density. The temperature of the flame was about 2,000 deg. C. absolute, that of the room 300 deg. C. absolute, giving the ratio 7:1; the figures could not be accurate, of course, since the gas flame consisted largely of coal-gas, and not of air. When the two Bunsen flames were burning close to one another, they would touch under the electric discharge, and no sparks could then be sent through the cold-air gap.

In the subsequent experiments Prof. Wilson made use of a wide insulated gas flame, 50 centimeters in width, 10 centimeters in height, produced by placing a large number of vertical quartz tube burners—in the former experiments the tubes had been of metal to serve as conductors—by the side of one another. By inserting into the flame two platinum electrodes attached to sliding stands and joined to a battery with a galvanometer in series, and by the further use of two platinum wires, joined to a quadrant electrometer, which would indicate the difference of potential of the flame between any two points, he proved that the relation between the current i and the potential V was $V = Ai^2 + Bdi$, where d was the distance between the electrodes and A and B were constants. If the d amounted to a few millimeters only, Bdi would be relatively small (except for very small i), and $V = Ai^2$; i. e., the current was almost independent of the length of the flame-gap then. In the first experiments shown with this arrangement the exploring wires were not wanted, and it was proved that the current through the flame was doubled when fourfold the number of cells was put in circuit; the volt-ampere curve was a parabola—not a straight line, as in the case of a wire. With the aid of the exploring wires it was afterward demonstrated that the fall of potential was not at all regular along the flame. Starting from the positive electrode, there was a slight fall; the potential then kept nearly constant until close up to the negative electrode, when the potential fell abruptly to zero. Thus nearly all the electromotive force was used up—in the flame as in a vacuum bulb—near the cathode, where the resistance was concentrated. The two streams of ions were moving in opposite directions, and the negative ions or electrons traveled much faster (10,000 centimeters per second for 1 volt per centimeter) than the positive ions, which moved only at about one-hundredth of the just-mentioned rate. Close to the positive electrode, the anode current would practically be carried by the negative ions; hence the high potential there.

With clean electrodes, Prof. Wilson continued, the flame current was very small; but various substances placed on the electrodes increased it. The case was analogous to the conductivity of water, which when pure was almost an insulator, but became a fairly good conductor when salt was dissolved in the water, in which it dissociated into ions. When a bead of salt (potassium carbonate was used) was held in the flame, the current might increase considerably. But it all depended upon the position of the bead with regard to the electrodes. The increase was only observed when the bead was close to the cathode, showing again that the main resistance was encountered close to the negative electrode. In any other portion of the flame the bead would locally diminish the resistance without much affecting the total current. When the salt was put on the cathode itself, the abrupt potential drop there almost vanished, and the potential gradient became practically uniform. When afterward more salt was volatilized in another portion of the flame—which had had very little effect previously—the current was noticeably increased. Such salt electrodes could be used as rectifiers for alternating currents, the resist-

ance of the flame being much smaller when the salt electrode was cathode than when anode.

Prof. Wilson next showed a table summing up the results of a long series of his measurements concerning the electric conductivity of alkali-salt vapors. The salt vapors flowed with a current of air along a platinum tube, heated in a gas furnace; an axial electrode was fixed in the tube, and the current was measured as passing from this electrode through the vapor to the tube. With electromotive forces of about 1,000 volts and at temperatures of 1,400 deg. C. and more, the current was proportional to the amount of salt passing through the tube and for different salts in equal quantities inversely proportional to the electrochemical equivalent of the salt. The product of current into equivalent gave the fairly constant value 2.67, and that signified that the quantity of electricity carried per molecule of salt was the same for all salts. That quantity was also found to be the same as in electrolyzed salt solutions, and thus it was established that Faraday's law holds for salts in the state of vapor, as well as for salts in solutions—an important generalization of modern electrochemistry, which we largely owe, we should repeat, to Prof. Wilson's own work.

From this analogy between salt vapors and salt solutions, the lecturer concluded, we should expect the sodium ions to travel toward the cathode in a vapor flame, as they did in a salt solution. He put some sodium chloride on one of two wires joined to an induction apparatus. The yellow sodium flame appeared only when the salted wire was the cathode. (The ordinary spark passing along a flame formed a bluish band.) This experiment proved that the positive ions (moving toward the cathode) contained the metal sodium as in a solution. But the analogy did not apply to the negative chlorine ion, which, in salt solutions, collected at the anode. The negative ions in flames always seem to be electrons, the negative corpuscles of very small mass, moving with a hundred times the velocity of the positive ion, which was an atom or a molecule.

THE SHRINKING OF THE EARTH'S CRUST.

WHAT IS HAPPENING TO THIS PLANET.

BY M. EIDEN.

THAT part of the earth's crust with which we are acquainted is composed largely of materials deposited from solution in water. These sedimentary rocks, as they are called, are usually arranged in numerous superposed and clearly distinguishable strata which, however, are seldom found in the horizontal position which they must have occupied in the beginning. As a rule the strata are inclined more or less steeply, and they are often bent into curved forms or abruptly broken off.

Stupendous forces must have operated to effect such changes in the positions of the solid rocks of the earth, and geology teaches us that these forces were engendered and these changes produced by the contraction of the earth's crust in consequence of the slow but incessant cooling of the mass of the earth. Most of the mountain ranges have been created in this way. Fig. 1 gives a purely diagrammatic representation of the formation of a mountain range by the crumpling of strata in consequence of contraction of the earth's crust.

The direct results of observation are shown between the horizontal line and the undulating contour of the mountains while the supposed course of the strata below the base line and above the present profile of the land is represented by dotted lines. The middle part, *A*, illustrates the formation of the fan-like arrangement of strata which is characteristic of the Alps, *B* shows a series of inclined folds, and *C* represents a fragment of a series of comparatively recent formation, completely isolated by erosion from the other parts of the series, which lie outside the limits of the diagram.

It is evident the strata, in their original horizontal position, before they were crumpled into mountain ridges, must have had a greater horizontal extension than they have now. This is illustrated by Figs. 2 and 3, in which the flagstaffs *a* and *b* are supposed to be firmly fixed in the rocks and to move with them. The distance from *a* to *b* is perceptibly diminished by the folding of the strata. In this way, it has been estimated, the formation of the Jura mountains produced a horizontal displacement of more than 3 miles, and the formation of the Alps caused a displacement of nearly 75 miles, or nearly 1/300 of the present circumference of the globe.

There is every reason to assume that immensely long intervals of time were occupied in the formation of the great mountain systems, but perceptible changes in the earth's surface have occurred during the comparatively brief period of human history. Such changes are usually accompanied by earthquakes,

FIG. 2.—STRATA BEFORE FOLDING.

which for this reason are called tectonic or dislocation earthquakes, and doubtless many such changes have occurred of which we have no direct knowledge, because they were not accompanied by great catastrophes and have consequently escaped attention.

After the great earthquake which visited the coast of California and almost destroyed San Francisco, on April 18th, 1906, changes in the relative positions of supposedly fixed points were found to have occurred throughout an extensive region. The greatest displacements were produced near the fissure, nearly 200 miles long, which was the most conspicuous result of the earthquake. Hence there was good reason to fear displacement of points of the recently completed fundamental triangulation of the Coast and Geodetic Survey. Many points, distributed over an area of more than 4,000 square miles, were redetermined, and displacements varying from 20 inches to 15 feet were found to have taken place. The displacements were greatest near the fissure and diminished rapidly as the distance from the fissure increased. Eastward of

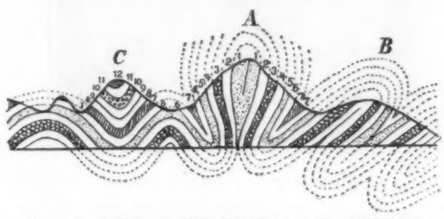


FIG. 1.—THE FORMATION OF MOUNTAIN RANGES.

the fissure the average displacement was about 5 feet at a distance of 1 mile, 3 feet at 2½ miles, and 2 feet at 4 miles. No displacement was detected at any greater distance than 4 miles to the east. On the west side of the fissure the displacements were still larger, amounting to nearly 10 feet at 1¼ miles, and nearly 8 feet at 3½ miles. The lighthouse on one of the Farallone Islands, far out in the Pacific and 22 miles west of the fissure, was displaced nearly 6 feet. These discoveries prove that horizontal displacements of the earth's surface can be detected and measured by triangulation.

In 1901 Loerkens called attention to the apparent progressive shrinking of the earth's crust indicated by the varying length of the earth's quadrant, as deduced from measurements of a degree of latitude, according to the following table:

		Meters.
230 B. C.	Eratosthenes	11,562,500
80 B. C.	Posidonius	11,100,000
827 A. D.	Almamon	10,360,000
1525 A. D.	Fernel	10,010,800
1633 A. D.	Norwood	10,050,800
1645 A. D.	Grimaldi	10,989,642
1669 A. D.	Picard	10,009,081
1719 A. D.	Muschenbroeck	10,004,000
1792 A. D.	Delambre	10,003,248
1801 A. D.	Swanberg	10,000,157

Fernel obtained a base line by measuring the distance from Paris to Amiens by counting the revolutions of a carriage wheel. Grimaldi, with the assistance of Riccioli, deduced the length of a degree of the meridian from the comparison of zenith distances observed from two stations. This method is simple but inexact, as it involves large corrections for atmospheric refraction which cannot be made with accuracy. If the results of Fernel and Grimaldi are excluded the table shows a steady decrease in the length of the earth's quadrant. Whether this decrease is real, or only apparent and due to errors of observation, may be determined by the theory of probability. If the discrepancies of a series of values of the same quantity are wholly due to accidental errors the most probable value of the quantity is the mean of the discordant values found by observation. Furthermore the number of positive errors, or differences from the mean, should equal the number of negative errors, and small errors should be more numerous than large ones. These conditions are not satisfied by the values of the earth's quadrant, the steady progressive diminution of which indicates a corresponding diminution of the real length of the quadrant. Hence, in the writer's opinion, the results of older and newer observations should not be combined, as they were in the computations of the earth's circumference made by Walbeck, Schmidt, Airy, Bessel, and Clark, between 1819 and 1866, but the most recent measurements should be calculated independently.

By measuring the length of a degree of the meridian with the greatest possible accuracy, and repeating the measurement at definite intervals with the same instruments and methods, it would be possible to determine whether the earth's crust is shrinking perceptibly or not, and whether the shrinkage is effected at a uniform rate or as the result of occasional violent convulsions. Such an investigation would greatly benefit the surveys, of all civilized countries which need only to be connected to furnish a triangulation which could be gradually extended over the entire land surface of the globe. This is one of the objects of the Institute of Central European Geodesy, which was founded in 1861 on the suggestion of Gen. Baeyer and extended in scope in 1886 by the inclusion of most of the civilized countries of the world. This institute might properly take up the question of the shrinkage of the earth's crust.

The same causes which produce horizontal displacements also produce elevations and depressions. We find, at elevations of many thousand feet above sea level, rocks which proclaim, by their chemical constitution and by the character of their fossils, that they were formed at the sea bottom. Great vertical displacements are usually accompanied by earthquakes, but measurable changes of level have taken place in comparatively short periods without perceptible seismic phenomena. In the vicinity of Apolda, Saxony (which, however, is situated in an earthquake region which has recently been again shaken) towers and other prominent objects can no longer be seen from points from which they were plainly visible a generation ago.

Lallemand, the director of the general leveling survey of France, recommends the repetition of accurate measurements of level at definite intervals for the purpose of detecting and measuring vertical displacements. From the known magnitude of the accidental and the systematic errors of the great leveling surveys of various countries Lallemand concludes that the smallest displacement that can be detected by the proposed method would be about 4 inches. As the changes of level, in general, take place very slowly, the interval between remeasurements should be at least 30 years. The International Geodetic Institute has adopted these suggestions and recommended the repetition of the fundamental leveling surveys of all countries, in whole or in part, two or three times in each century.

From the data already collected we may assume with reasonable certainty that the strata of the earth's crust, including the oldest formations, are still subject to gradual or convulsive displacements, both horizontal and vertical. Fixed points of reference for horizontal displacements are furnished by astronomical determinations of latitudes and longitudes, but only relative vertical displacements can be determined, because we have no point of reference of which the elevation can be regarded as absolutely unalterable. The fixity of some points may be established by many repetitions of the general system of levelings, and then this point may be taken as a point of reference and the absolute changes of level thus obtained.

FIG. 3.—STRATA AFTER FOLDING.

The repetitions of horizontal and vertical surveys here suggested will doubtless furnish data from which at no very distant epoch, inferences regarding the ultimate fate of the earth may be drawn.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Prometheus.

HYDROID ZOOPHYTES.*

STUDIES IN MARINE LIFE.

BY G. E. BULLEN.

To THE student of marine invertebrate biology there is, perhaps, no other group of lowly organisms which present a greater variety of exquisite forms or offer more bionomic interest than do the hydroid zoophytes with their offspring the Hydromedusæ or jellyfishes.

Hidden within the dark recesses of rock pools, and discarded in bunches from the fisherman's trawl, are to be found numerous examples, which rival in beauty of form, if not always color, the choicest blossoms of a hothouse.

It is needless to remark, however, that it is not until the microscope is brought into use that the delicate structure of these "flower animals" is revealed. For the various common species which are to be met with on any sandy beach among seaweed and other *débris* appear at first sight to be of no particular interest. These, however, as a rule, are but the mere skeletons of former living colonies, and to view them in all their beauty the naturalist's dredge must be employed, or for certain littoral species diligent search should be made in the rock pools. Often these latter are so completely covered with foreign matter —alga, diatoms, protista, etc.—that they are indistinguishable to any but the most practised eye. A specimen of this description, *Bourgainvillia ramosa*, is shown in Fig. 1, which has been sufficiently enlarged to show a certain amount of the investing matter.

In order to understand something of the habits of "hydroids," it is necessary to investigate their structure, and the following microphotographs have been taken from specimens exhibiting certain particular morphological characters.

In Fig. 2 is seen an example of a hydroid, *Clava multicomis*, in a simple form nearly approaching the text-book type, *Hydra viridis*. Here it will be seen that the "head" is furnished with a number of cylindrical tentacles similar somewhat to those of a sea anemone.

These are the means by which the animal procures its food. This consists of animalcules often of a fair size, microscopically speaking, for these creatures have an insatiable appetite and prey upon anything which comes in their way and is minute enough for them to swallow whole.

The tentacles themselves are, indeed, formidable "breadwinners." They are, more or less, hollow throughout their length, and the outer skin is studded thickly with minute cavities. Within each of these "thread cells," as they are called, is contained a formidable battery of minute darts or harpoons, each attached to the side of the cell by a long, slender thread.

When some unwary victim happens to come in contact with one of the outspread tentacles, the darts are instantly expelled from the cells and enter the unfortunate's body, completely paralyzing it. It is then drawn by means of the thread toward the tentacle which, in turn, passes it toward the mouth, situated in the center of the flower-like head. The arrangement of these thread cells on the tentacles of another species, *Coryne vaginata*, common in many rock pools, is well seen in the next illustration (Fig. 5). Returning to our original example, however, it may be mentioned that the body consists throughout of two principal layers of *chitin*, the *ectoderm*, and *endoderm;* a third middle layer, the *mesoderm*, is recognized by histologists, but no reference will be made to it in the present description. When the food is passed into the body cavity of the hydroid it is rapidly digested, and by a number of vibratile cirri with which the *endoderm* is furnished, the digestible and alimentary matter is circulated throughout the entire colony; the rejectamenta are expelled from the mouth. The word "colony" has been used, for, in the majority of species, the animal does not remain solitary, but by sending out roots from the base, the *stolons*, or by branching in its upward growth develops into numerous "heads" or *polypites*, each provided with a crown of tentacles, a condition which is shown in certain of the illustrations.

Fig. 5.—Polypite (Coryne). Much Enlarged to Show Thread Cells.

Fig 6.—Polypites (Syncoryne). Much Enlarged to Show Attached Embryos.

It is, however, in the propagation of a certain form over a wider area that the hydroid offers the greatest interest. This brings us to a consideration of the second important aspect of the zoophytes' morphological economy, viz., the reproductive system. In the majority of cases propagation consists in the liberation of free-swimming embryos, either as *medusæ* (i. e., jellyfishes), or in another form, termed *planulæ*. In Fig. 6 are shown a number of undeveloped embryos still attached to the parent stock. Before these were developed the several heads presented an appearance somewhat similar to that seen in Fig. 5, but during the growth of these *gourds*, as they are termed, the tentacles atrophied. The body cavity and alimentary system being common to the entire colony, nutrition to these developing embryos is derived from the labors of other *polypites*, still furnished with tentacles.

The classification of the hydroid zoophytes is based largely upon the form presented by the *cœnosarc* or the hard chitinous *ectoderm*. Those in which the flower-like heads, or *polypites*, and developing embryos are protected by special growths of this substance, to form *calycles*, or cups, and *embryo capsules*, are termed the *Thecaphora*, in contradistinction to the *Ath ata*, in which this protection is lacking.

The types hitherto touched upon, together with that interesting species, *Hydractinia echinata* (Fig. 7) which lack of space forbids us to describe, belong to this latter group. In the other main division the elegant cup-like expansions of the *cœnosarc*, to form protection for the fragile *polypites*, and the highly ornate form of the urn-like embryo capsules, add considerably to the exquisite beauty of these interesting organisms.

The *calycles* are to be seen in the illustration (Fig. 9) depicting a small colony of *Clytia Johnstoni* having the polypites themselves contracted.

These appendages may either be borne upon ringed stems, which allow a certain degree of free movement, or else they are supported in rows upon the branches of the colony. In this style of growth there is much diversity in arrangement in different forms. Sometimes the cups are distributed in regular alternate intervals on each side of the stem (as in Figs. 3 and 4); less frequently on one side of the branch only (Fig. 8) in the same plane; and in a few forms they are closely clustered with the lips of the cup pointing in alternate directions. In certain types there is a jointed lid to the top of the embryo capsule and calycle, which affords perfect protection to the animal within.

The capsules show a still wider variety of forms, each more or less elegant, and suggestive of ancient Greek vases. A fair example of the less ornate type is shown in Fig. 3, the capsule of a species of *Diphasia*, and in the following illustration (Fig. 4) are seen several *in situ* upon the branches of the colony of another kind, *Sertularella tricuspidata*. An entirely different form of embryo case—it can scarcely be termed capsule—exists in all species of the genus *Aglaophenia*, an example of which is shown in Fig. 8. This is termed the *corbula*, within the wide ribs of which the developing young are contained in a thin enveloping sac.

The early life and growth of the liberated medusa is too deep a subject to be discussed even superficially here. Certain forms are shown in the next illustration (Fig. 5). It may be mentioned, however, that, despite the apparent total dissimilarity of form presented by these embryos from the parent hydroid, a certain analogy exists between them in several morphological characters.

Fig. 1.—A Colony of Zoophytes (Bourgainvillia), Microphotograph x 10.

Fig. 3.—Embryo Capsule of Zoophyte (Diphasia). Much Enlarged.

Fig. 2.—Single Individual of the Club Zoophyte (Clava). Much Enlarged Microphotograph.

Fig. 4.—Portion of Zoophyte (Sertularella). Much Enlarged, Showing Embryo Capsules.

Medusæ, in common with hydroid colonies, are highly phosphorescent. On a dark night, when these creatures are plentiful, the sea often appears to be lit up with a myriad of tiny stars. Wherever sudden disturbance occurs, such as the rapid passing of a shoal of drift fish across the bows of an approaching vessel, the sea fairly glares with luminosity. In a few forms, however, the embryo is never freed from

* Knowledge and Scientific News.

the capsule, but remains attached to the top of the rim throughout its existence. An instance of this is shown in Fig. 10, a specimen of *Gonothyræa loveni*, where two, three, and even four embryos are shown crowded together outside with more to follow within the capsule.

In conclusion it may be said that we have descanted more upon the beauty of these "flowers of the sea" than their representation by microphotographs justify. This is, perhaps, only too true; yet it should be remembered that there can be no comparison between fresh living specimens and those prepared, however carefully, for microscopic examination.

HISTORY OF THE WHALE INDUSTRY.

CONTRARY to a very prevalent opinion that obtains among a vast number of our fellow men whose occupations and environments are in no wise connected with seafaring life, the whale is a true mammal, and in no respect is it a species of the piscatorial family, except in so far as it finds its home and nourishment in the waters of the sea instead of on land. In general structure it is much like our ordinary quadruped, having well-defined shoulder and hip joints, though they are only partially developed. Owing to its tremendous size, averaging about fifty feet in length and twenty-four feet in girth and weighing from seventy to one hundred tons, it is manifest that it could never have been intended for a land resident, the utter impossibility of such a huge mass locomoting over the uneven topography of the earth's surface being at once apparent, even though food of suitable character to sustain life could be secured. Being a true mammal, it is possessed of a circulatory system identically similar to that of farm animals. Warm blood courses through its veins; it breathes air and can remain submerged for as long a period as fifteen minutes, a much greater time than it is possible for any other inhabitant of the earth to go without replenishing its air supply.

Another marked similarity exists in its procreative functions. The young whale is calved alive and nourished with a rich milk from the udder of its female progenitor. In rare instances twins are born. These facts have been revealed through embryology.

The whale inhabits every sea of the globe, and the supply seems undiminished. Man is its only enemy, and hence its depopulation has been immensely smaller than that of any other of the earth's living beings. Its most prolific breeding and feeding area is the waters of the North Pacific Ocean. This is accounted for by the action of the Japan current, which gives a variety of water temperature nowhere else to be found. Ships from every whaling port in the world have in the past made annual cruises to this region in search of these profitable monsters of commerce.

The principal member or group of the whale family is the bowhead, the most valuable of all, from which as much as $2,000 worth of balena, the whalebone of commerce, and whale oil alone are extracted. This species will average 3,000 pounds of whalebone. The right whale, next in importance, contains about one-half as much whalebone and equally as much oil and other by-products. The sperm variety is chiefly valuable for its contents in sperm oil, as much as fifty-five barrels of the pure fluid being pumped from the head alone, the latter appearing to be fully one-third the size of the whale. These three members of the whale family are of historical fame, the ones upon which the industry in its earlier history was founded, and in whose quest countless lives have been sacrificed, so that their immensely rich products might be recovered for the comfort and convenience of our advancing civilization.

In former times, and before the introduction of the permanent whaling stations on shore, the other or lesser valued varieties, consisting of the sulphur bottom, grampus, finback, and humpback, were not sought or taken; but latterly with modern methods of capture, as exemplified by the harpoon gun, swivel mounted on the bow of a fast steamer, their day of security from the destroying hand of man is at an end, and they too must sacrifice their lives to the lust for wealth. The value of the whale as an article of commerce was first discovered by finding the carcass of an extinct whale, which had been washed ashore on the coast of the Mediterranean Sea. The residents were jubilant to find that it contained vast quantities of oil, with which the dip lamps, used in their holy worship services, might be kept lighted. Since then the whale has been hunted in a more or less desultory way. Not until the fifteenth century had the industry assumed large or international importance. At that period many European governments came near to

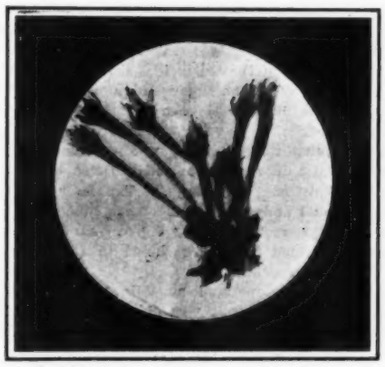


Fig. 7.—A Small Colony of Zoophytes (Hydractinia). Much Enlarged.

serious complications through an arbitrary division of the fishing grounds, and acts of piracy upon the part of their citizens. In some instances companies were organized solely to prey upon the cargo of returning whalers, this being a cheaper and easier method of securing the product than by engaging in the hunt for the mammal direct. Happily, however, the discovery that whales were abundant in all waters led to amicable treaties of division being arranged, and peace was brought to the industry. The American whale fisheries began in colonial days, as early as 1614. The colonists along the New England coast took up the business with avidity, and from 1660 to 1765 it was the most important of all the industries engaged in by our early fathers, and from Cape Cod and New Bedford several sloops were sent on their voyages with great success. The war of independence and the war of 1812 caused temporary cessations of the business. It was revived with the declaration of peace, and grew rapidly until 1854. The American whalers had 678 ships and barks, 35 brigs, and 2 schooners actively engaged, giving employment to over 25,000 men. During the twenty-six years from 1835 to 1861 the American whalers produced 3,671,772 barrels of sperm oil, 6,553,014 barrels of whale oil, and 66,687,500 pounds of whalebone. The total cash value of this product was $272,274,916.27. It required the capture of 100,000 whales to furnish this great amount, and all these were taken by the primitive hand method of harpooning. The business had grown to such large proportions that over $70,000,000 was invested by American whalers, and employment was given to over 70,000 people.

It must be mentioned that during this period of great prosperity all of the now valuable by-products, such as whale meat, leather, tallow, guano, bone fertilizer, glue, and whale amber or leather preservative, were not utilized at all, though their aggregate value was fully as great as that recovered, and represents a net loss of over $275,000,000 to the industry during that time, as compared with the methods now employed, whereby all of these products are turned to profitable account. The civil war effectually placed an embargo on the business, except for the few vessels that left San Francisco during that time for Northern Pacific waters. It also practically sounded the death knell of whaling as then conducted for the oil and bone only, as in 1876 Capt. Sven Foyn, of Norway, invented the harpoon gun for attacking the whale, and by this method a mechanism succeeds the old and dangerous system. He built a steamer equipped with this powerful machine gun, capable of firing into the body of the whale a bomb-laden steel harpoon over six feet in length, to which is attached a 4½-inch Russian hemp line of the finest quality and by which the mammal is drawn alongside the steamer, to be towed later to the packing and rendering plants on shore. By this means the capture of the whale is made cheaply, harmlessly, and expeditiously as compared with hand harpooning from the bow of a small lifeboat.

When landed at the modern whaling stations, the huge carcass is drawn up an inclined plane to the slaughtering department, and there its various products are reduced to marketable shape. Immediately the enterprise proved again most successful, and within a few years Foyn had established twenty-five different stations along the coast line of his country and became immensely wealthy. In 1898 some of his fellow countrymen, seeing the big profits to be earned, embarked in the business along the Newfoundland coast; their success was so immediate and marked as to attract the attention of Boston and Canadian capitalists, who in 1901 established the first modern whaling station in those waters. In 1901 they capitalized their venture for $100,000, and they are now employing a capital of over two and one-quarter million dollars, and have declared annual dividends as high as eighty per cent on that amount. Within four years from the date of their entry into Newfoundland they had established no less than twenty-one stations, and have now invaded the greatest of all whaling grounds, the North Pacific Ocean.

About two years ago in December, 1906, the first modern whaling station on the entire Pacific was erected and in the first seven and one-half months of operations 176 whales were captured, whose products netted $257,110, being 145 per cent on the money invested in steamers, station, and expense of business to that date.

Readers who are not familiar with conditions should understand that a whale consists in part of ninety barrels of oil, sperm, blubber, and carcass, valued at $14 per barrel; from 250 to 3,000 pounds of whalebone worth over $400 per ton; over ten tons of whale meat, a cheap nutritious food, which sells for $65 per ton. About 800 square feet of leather is obtained, and is well adapted for use in the upholstery and bookbinding industries. Four tons of whale guano, made from the contents of the stomach, blood, and refuse pieces of flesh, is another of the many merchantable products, now worth $40 per ton and used by the sugar planters of Hawaii. Three tons of bone fertilizer, valued at $40 per ton ground, finds a ready market in this country. Upward of 600 pounds of tallow furnishes the raw material for soap and candle making, and a like amount of glue goes to our furniture factories. Whale amber, the finest leather preservative known, is used by our tanners and harness makers. Ambergris, the base of high-grade French perfumes, is one of the very valuable by-products of the whale, and even the tail, which averages a ton in weight, is eagerly sought by the Japanese at $50 per ton. Here is an array of by-products taken from the whale of every variety, every one of which is of great value and with an ever-increasing market at hand in

Fig. 8.—Part of Zoophyte (Aglaophenia). Much Enlarged, Showing Corbula.

Fig. 9.—Small colony of Zoophytes (Clytia). Much Enlarged, Showing the Calycles.

Fig 10.—Portion of Zoophyte (Gonothyræa). Much Enlarged, Showing Embryos Attached to Top of Capsules.

STUDIES IN MARINE LIFE.

which they can be sold for cash. No undeveloped industry presents such possibilities of profit and expansion. It is yet in its infancy. The raw material upon which it is based (the whale) is to be found on the Washington and Alaskan coast in abundance. Those familiar with conditions predict that the supply for twenty modern stations, each using 200 whales per annum, is ample for over fifty years. It will be remembered that under these new methods all varieties of the mammal, humpbacks, finbacks, sulphur bottom, grampus, and blue whales, are as valuable for their by-products as are the bowhead and sperm whale, which formerly were the only ones sought for. The estimated present value of each whale taken—and this means every kind found in our waters—is roughly placed at $1,700. Basing the catch per annum for a station and steamer at 200 whales, we have a gross output in the crude of $340,000.

PRODUCTION OF ALCOHOL FROM CELLULOSE.

HOW WOOD AND WOOD PRODUCTS MAY BE EMPLOYED.

BY TH. KOERNER.

THE idea of obtaining alcohol from wood is not new. In 1819 Braconnot published a method of converting woody fiber into fermentable sugar. The wood was first treated with cold concentrated sulphuric acid, which caused a great elevation of temperature and an evolution of sulphur dioxide. Water was then added, the mixture was filtered and the filtrate was neutralized with chalk. A gummy mass was thus precipitated which was converted into fermentable sugar by the action of dilute sulphuric acid. In the following year Vogel repeated Braconnot's experiments and extended them to paper, cotton, straw and cork. In 1854 Arnould claimed to have converted from 80 to 90 per cent of wood into soluble products by treating it with rather more than its own weight of strong sulphuric acid. In 1855 Meisens substituted treatment with weak acid (3 to 5 per cent) in a digester at temperatures up to 350 deg. F. A factory for the production of alcohol from wood was started in Paris in 1855, but it does not appear to have existed many years. In Geneva, some years later, an attempt was made to produce alcohol, on a commercial scale, from residues of wood left in paper making.

In 1867 Payen claimed to have obtained alcohol from the lignin contained in the wastes of the manufacture of paper, and Matthews claimed to have obtained fermentable dextrose from peat.

In 1894 the Norwegian chemist Simonsen patented, in Germany, a process for the rapid saccharification of substances containing cellulose by treatment with weak acids (4/10 to 8/10 per cent) under a pressure of 7 atmospheres or more. The process occupied from 10 to 30 minutes. A kilogramme of wood yielded 60 grammes of alcohol—that is to say, the yield was 6 per cent, which was very small in comparison with earlier claims.

In 1898 Simonsen published the results of experiments on the influence of pressure, time, and the quantities of water and acid employed in the inversion of substances containing cellulose. From sulphite-cellulose he obtained 45 per cent of sugar, which he regarded as the maximum yield, because part of the sugar formed is destroyed by the heat of the reaction. He estimated the sugar by Fehling's method and assumed, after a single test, that all of it was fermentable. With sawdust he obtained the best yield by heating the sawdust 15 minutes with five times its weight of ½ per cent sulphuric acid, under a pressure of 9 atmospheres, but few experiments in fermenting the sugar gave positive results. The highest yield of absolute alcohol was about 5 per cent of the weight of sawdust. Simonsen concluded that wood could be inverted more easily than pure cellulose, but that all sugar came from the cellulose of the wood.

In 1899 Classen patented a process in which sawdust is mixed with sulphuric acid of 57 deg. Baumé, and subjected to great pressure. The pressed mass is then broken up and boiled with water. In other patents of the same year he claimed the employment of sulphurous acid, alone or in conjunction with sulphuric acid, or with chlorine, air, or oxygen. In the following year he patented the treatment of wood with vapor of sulphuric anhydride.

In 1901 Gentzen and Roth patented the employment of ozone for the purpose of converting lignin into fermentable sugar and destroying substances which prevent fermentation. The patentees claimed to have obtained from 34 to 40 per cent of dextrose from pine and fir wood. They used 3 or 4 per cent sulphuric or hydrochloric acid under a pressure of 20 atmospheres. The process occupied from 10 to 30 minutes.

In 1904 Reiferscheidt reviewed the subject experimentally and concluded, with Simonsen, that the cellulose of wood is the sole source of sugar and that the presence of lignin rather obstructs the process of saccharification. In experimenting with Classen's processes he obtained the best result by treating the material one hour with 9 per cent sulphurous acid at a pressure of 4 or 5 atmospheres and a temperature of nearly 300 deg. F.

In 1905 Boernen obtained an English patent for a process employing 5 per cent solutions of caustic alkalies at about 90 deg. F., and boiling the liquid after the unaffected residue of the wood has been removed by filtration.

It appears from this historical sketch that the estimates of the yield of sugar and alcohol differ very greatly. The oldest estimates are the highest. Braconnot claimed to have obtained from lignin more than an equal weight of sugar, and Arnould made a similar claim in regard to wood. Often the yield is given simply as "very large." The later claims include alcohol and also become more modest until, in 1898, Simonsen obtains only 6 per cent of alcohol, a result confirmed by Reiferscheidt in 1904, and also by my own experiments.

In general, I operated as follows: Sawdust, sulphite cellulose, or straw was digested for a longer or shorter time with dilute or concentrated sulphuric acid, with or without other reagents.

The digester was of copper, lined with lead, and held about two quarts. It was heated on a water bath or by a Bunsen flame which was not in contact with it. The acid solution obtained by this process was filtered. The color of the filtrate was red, orange or brown, and was darkened by the addition of alkalies. In the first experiments the sugar was calculated from the weight of cuprous oxide produced by treating the liquid with Fehling's solution, but I soon discovered that the amount of alcohol which corresponded to the quantity of sugar thus found did not always agree with the amount of alcohol obtained by actual fermentation and distillation. In some cases, the difference was less and in others much greater than the unavoidable loss in distillation (which is from 10 to 20 per cent), as appears from the following table:

Raw Material.	Reagent and Process.	Percentage of Alcohol—Calculated from Cuprous Oxide.	Percentage of Alcohol—Obtained by Distillation.
Sawdust.	½ per cent sulphuric acid	5.2	5.2
Sawdust.	½ per cent after steaming	7.4	6.8
Sulphite cellulose.	½ per cent, with 2 per cent hydrogen dioxide	16.1	14.6
Straw.	½ per cent, with 2 per cent hydrogen dioxide	8.5	8.4
Sawdust.	½ per cent, with sulphurous acid	2.4	1.7
Sawdust.	½ per cent, with sulphurous acid	9.6	5.5
Sulphite cellulose.	½ per cent at 8 atmospheres	10.9	8.4
Straw.	½ per cent	8.5	5.4

The great difference between the calculated and the real percentage of alcohol in the last four experiments is due to the presence of reducing substances, other than sugar. In another experiment, in which the calculated percentage of alcohol was 7.7 and the real percentage only 2.1, the presence of a large quantity of furfurol was discovered. Simonsen also detected furfurol by its odor.

For these reasons the quantity of alcohol was always determined directly. Part of the filtrate from the digester was neutralized with chalk, again filtered, acidified with a few drops of phosphoric acid and fermented with yeast for two or three days at about 80 deg. F. The fermented liquid was freed from yeast and distilled after a little tannin had been added. When a third of the liquid had passed over the operation was stopped and the distillate was mixed with a little chalk for the purpose of neutralizing any acetic acid that might have been formed, and redistilled one or more times, according to its strength. The specific gravity of the final product was always measured at the same temperature, with the pyknometer.

A series of experiments was made in order to determine whether sugar can be obtained from lignin as well as from cellulose. Simonsen's experiments appeared to prove that the sugar was derived entirely from the cellulose, as he obtained 45 per cent of sugar from pure cellulose but only 20 per cent from wood containing 50 per cent of cellulose. But he estimated the sugar by Fehling's method which, as we have seen, is unreliable. Hence I made comparative experiments with equal quantities of sawdust, sulphite cellulose and straw, digesting each with about twelve times its weight of ½ per cent sulphuric acid at a pressure of 6 or 8 atmospheres for 2 hours, and then fermenting and distilling as described above.

The percentages of alcohol obtained were:

	From sawdust.	From sulphite cellulose.	From straw.
	5.2	13.7	9.6
	6.8	12.0	..
Mean	6.0	12.8	9.6

The yield from cellulose was about twice that from sawdust. Assuming that the sawdust was half cellulose, this result confirms the theory that all of the sugar is derived from the cellulose and none from the lignin of the sawdust. In order to attain certainty on this point the cellulose content of wood and of sulphite cellulose was determined by the method of Fremy and Terreil. The wood (or sulphite cellulose) was steeped in chlorine water for 36 hours and then boiled with potash, which dissolved most of the other ingredients, leaving a residue of nearly pure cellulose, which was washed with dilute acid, dried, weighed on a platinum dish, and incinerated. The dish and ash were then weighed. The difference between the two weights was taken as the weight of cellulose. Two specimens of dry wood thus yielded 49.8 and 48.3 per cent of cellulose, while two specimens of sulphite cellulose yielded 83.6 and 79.7 per cent of pure cellulose. The cellulose content of straw was determined by the method of Henneberg and Wender. Two specimens yielded 69.2 and 68.7 per cent of cellulose.

The mean percentages of cellulose and alcohol are approximately proportional, as shown below:

	Cellulose.	Alcohol.
Wood	49.0	6.0
Sulphite cellulose	81.6	12.8
Straw	68.9	9.6

Two experiments were made to determine the effect of sulphurous acid. Sawdust was digested, first with 2 per cent sulphurous acid, and then with ½ per cent sulphuric acid. 4.2 and 5.5 per cent of alcohol were obtained. As sawdust digested with sulphuric acid alone yielded 6 per cent of alcohol, the preliminary treatment with sulphurous acid is worse than useless.

The substance known as hydrocellulose, which may be represented by the formula $C_{12}H_{22}O_{11}$, may be regarded as formed by the combination of two molecules of cellulose (assuming the simplest possible formula for the latter) with one molecule of water: $2C_6H_{10}O_5 + H_2O = C_{12}H_{22}O_{11}$. As hydrocellulose (like cane sugar, which has the same empirical formula) stands midway between cellulose ($C_6H_{10}O_5$) and glucose ($C_6H_{12}O_6$) which differ by a whole molecule of water (H_2O), it appeared likely that sugar could be obtained more readily from hydrocellulose than from cellulose. I digested hydrocellulose (prepared by Ulzer's method) with 12 times its weight of ½ per cent sulphuric acid at about 315 deg. F. for three hours, and obtained, by fermentation and distillation, 18.0 per cent of alcohol. This is by far the highest yield obtained from any material, as appears from the following table of mean results:

	Per Cent of Alcohol.
Wood yielded	6.0
Straw yielded	9.6
Sulphite cellulose yielded	12.8
Hydrocellulose yielded	18.0

I then attempted to produce hydrocellulose or similar compounds by oxidizing wood, etc., during the process of saccharification, although the alcohol yielded by hydrocellulose itself was found to be diminished from 18 to 11 per cent by the addition of hydrogen dioxide, and to 4 per cent by the addition of chromic acid.

Equal quantities of sawdust, sulphite cellulose, and straw were digested 3 hours at about 8 atmospheres

and 328 deg. F. with water containing 2 per cent of hydrogen dioxide and ½ per cent of sulphuric acid. The percentages of alcohol compare as follows with those obtained with sulphuric acid alone:

	Without Hydrogen Dioxide.	With Hydrogen Dioxide.
Wood	6.0	9.9
Sulphite cellulose	12.8	14.6
Straw	9.6	10.3

Hence it appears that hydrogen dioxide increases the yield of alcohol, especially from wood.

In another series of experiments the hydrogen dioxide was replaced by an equivalent quantity of potassium bichromate, the injurious action of the chromium compounds on the yeast being prevented by precipitation with lime before fermentation. The addition of the bichromate greatly diminishes the yield of alcohol in all cases, as appears from the following table:

	Without Bichromate.	With Bichromate.
Wood	6.0	3.2
Sulphite cellulose	12.8	2.3
Straw	9.6	3.2

In another series an equivalent amount of potassium persulphate was substituted for the bichromate, with similar results:

	Without Persulphate.	With Persulphate.
Wood	6.0	4.2
Sulphite cellulose	12.8	7.3
Straw	9.6	2.6

Roth and Gentzen in the application for their patent covering the employment of ozone in the saccharification of sawdust assert that ozone not only promotes fermentation but also converts lignin into sugar. They also assert that the substances associated with cellulose in wood are very similar to carbohydrates, but although the sulphite liquor of cellulose factories employing the sulphite process contains a great deal of lignin Lindsey could obtain from it only small quantities of levulinic acid, the production of which, according to Wehner, is a certain proof of the presence of carbohydrates. I treated sawdust with increasing quantities of ozone and then digested it with 3 per cent sulphuric acid (the strength recommended in the patent). The alcohol obtained decreased steadily from 6.6 per cent to 1/3 per cent, the decrease being nearly proportional to the quantity of ozone employed. Similar results were obtained with sulphite cellulose.

SUMMARY.

For wood my results agree with those of Simonsen and give a yield of absolute alcohol equal to 6 per cent of the weight of dry wood. Sulphite cellulose contains about twice as much pure cellulose as dry wood contains, and yields about twice as much alcohol. This proves that the sugar which is converted into alcohol is derived from cellulose and not at all from lignin. The addition of sulphurous acid, recommended by Classen, diminishes the yield of alcohol in all cases.

The yield of alcohol is increased by hydrogen dioxide but diminished by stronger oxidizing agents. These results suggest that hydrogen dioxide converts the cellulose into hydrocellulose, which I found to yield a very high percentage of alcohol, but that the stronger agents oxidize the cellulose to a higher stage, producing non-saccharifiable compounds.

The employment of ozone recommended by Roth and Gentzen diminishes the yield of alcohol in proportion to the quantity of ozone used.

The actual yield of alcohol from wood, 6 per cent, is less than one-quarter of the theoretical yield, for wood is nearly half cellulose, and cellulose, theoretically, should yield 56.91 per cent of alcohol. This great disparity suggests the hypothesis that a portion of the complex cellulose molecule $(C_6H_{10}O_5)_x$ is split off and converted into sugar.—Condensed from Zeitschrift fuer Angewandte Chemie.

FLOWER PIGMENTS.

THE SCIENCE OF A BLOSSOM'S HUE.

BY C. M. BROOMALL.

TO LOOK upon the wonderful and varied hues of the flowers that surround us and not feel a desire to know something of the pigments that produce their colors is well-nigh impossible. Unfortunately, however, it is a subject about which there is much yet to learn, as is evidenced by the comparatively scant literature relating thereto and the absence of a consensus of opinion regarding the chemical and physiological relations of the pigments.

A few easily performed tests with the pigments as extracted from many kinds of flowers, both cultivated and wild, will exhibit certain reactions common to all flowers of a given color, which reactions are very suggestive both from a physical as well as from a physiological standpoint.

Thus, if an alcoholic extract is made of the petals of a flower we find it to exhibit, at least in the great majority of the cases, the property of changing color as the reaction of the solution changes. In other words, the alcoholic solution makes what chemists call an "indicator," that is, a solution which turns one color when a drop of alkali is added and another color with a drop of acid. In the tests by the writer sodium hydroxide and nitric acid were found to be very satisfactory reagents, although care had to be exercised not to add an excess. Of course other alkalies and acids will answer as well.

A series of tests covering a considerable number of plants indicates the reactions given below as applicable to the variously colored flowers. The flowers, in accordance with the reactions, may be divided into four classes: (1) The red flowers; (2) the yellow flowers; (3) the purple flowers, and (4) the blue flowers. As regards the existence of a really blue flower, however, the writer is inclined to be somewhat skeptical. Testing the alcoholic solutions made from the petals of these four classes of flowers we find the following reactions: (1) Red flowers, green with alkali, red with acid; (2) yellow flowers, green with alkali, yellowish or colorless with acid; (3) purple flowers, green with alkali, purple with acid, and (4) blue flowers (so-called), green with alkali, colorless or very faintly bluish with acid.

These reactions the writer has found to occur in solutions made from many kinds of flowers, both wild and cultivated. With the exception of solutions from Class 4, the color changes are strong and delicate and capable of reversal back and forth a number of times. As regards Class 4, only two or three flowers were found which really seemed blue to the eye and which gave reaction 4 unmasked by the purple reaction.

While these reactions of course may not be true for all flowers, yet in no case did they fail to appear in the writer's extended tests. Considering the large number of tests made they certainly seem generally enough true to warrant further inquiry. Let us see to what results we are led.

In the first place, we see that in all cases the color is green with alkali, while with acid the solution takes more or less the color of the mature flower as we ordinarily see it. Bearing in mind, however, the fact that purple is not a simple color but a combination of red and blue, the reactions lead us to suspect that we are dealing with but three pigments, which, in the acid condition, are respectively red, yellow, and blue in color. But these are the three primary pigments from which, by various combinations, all colors may be produced. Hence, granting the existence of one or more of these three pigments in the flower petals, we see how it is possible to account for all the varied hues of the flowers around us. So much for the physical side of the subject.

But a still more interesting correlation results from a consideration of the physiological relations of the pigments. Thus, we know that all plants live, as it were, a dual existence. That is, in sunlight they breathe in carbon dioxide and exhale oxygen, while at night or during great activity they live like animals, using up the oxygen from the air and producing carbon dioxide. These processes are always going on more or less simultaneously. During the time of flowering we know that the animal side of the plant is very active, as a considerable production of heat, which can only result from oxidation, is then found to occur in the flowers. This means that the flowers at this time are the seat of active production of carbon dioxide. But since this compound is acid in reaction, it follows that the pigments in the flower petals will take on that color which corresponds to the acid reaction; that is, the flower will assume its ordinary color as met with, depending upon what pigments are present. In the earlier life of the flower, however, when it is simply living with the vegetable side of life predominant, there is not an acid reaction due to the presence of carbon dioxide and the petals are green, as we find them in young flowers. If the more or less greenish petals of an immature red flower, for example, be placed in water slightly acidified, they will assume the red color of the mature flower. This shows that the pigment is already present but that the reaction is not acid.

The theory of the physiology of the pigments, therefore, as far as it goes, may be briefly summarized as follows: In the petals of the young flower there exist certain of the three primary pigments in certain proportions. The reaction is alkaline, however, and no matter what pigments are present the color is green. But as the animal life of the flower becomes more pronounced and the bud matures, the carbon dioxide thus produced changes the reaction of the fluids of the petals to acid and the red, yellow, or blue color of the pigment or pigments develops and the flower gradually assumes its final hue.

As regards the chemistry of flower pigments but little seems to be known, and it is doubtful whether any of them have been isolated in the pure state. It is interesting to note, however, that despite their extreme susceptibility to change of reaction they are really quite stable. Thus, in some pansies (of the variety with both purple and yellow petals) which had lain between the leaves of an old book boxed up and packed away since about 1860, the respective purple and yellow pigment reactions were shown very nicely. And again, a solution from a purple pansy which had lain pressed away in an envelope in a book since "Easter Sunday, 1847," according to the label, changed back and forth between green and purple almost as markedly as a solution made from a fresh flower.

BUDAPEST NEWS-TELEPHONE.

IN reply to a Missouri inquiry in regard to the Budapest news-telephone system, Consul-General Paul Nash writes as follows:

This system, which has been in successful operation in the capital of Hungary for several years past, is owned and managed by a private corporation, whereas the regular telephone system is owned by the government and administered by the ministry of posts and telegraphs. The annual subscription, $7.31, paid quarterly in advance, entitles the subscriber to two receivers and the full service of news, music, etc., the subscriber to pay the expenses of installation and removal, generally about $8.50. The service begins at 8.55 A. M., when a buzzing noise, loud enough to be heard across a large room and lasting for fifteen seconds, announces the correct time. At 9:30 the day's programme of important events is announced; that is to say, the ceremonies, lectures, plays, races, etc. At 10 and 11 o'clock stock quotations and general news items are given.

At noon comes a second announcement of the correct time, followed by parliamentary news and general items of interest. At 12:45 stock quotations from the local, Vienna, and Berlin exchanges and general news. At 2 o'clock more parliamentary and general news, and at 3 P. M. the closing prices of stocks, meteorological forecast, local personals and small items, and in winter the condition of the various skating places. At 4 P. M. court and miscellaneous news. From 4.30 to 6.30 military music from one of the great cafés or gardens. In the evening the subscriber may choose between the royal opera or one of the theaters, and later music by one of the *tzigane* orchestras.

This programme is sufficiently varied to satisfy the desires of all classes of subscribers, and in general the service seems to give the utmost satisfaction. Its advantages are so manifest that no comment appears necessary.

While the slide rule has only become universally used for calculating purposes during comparatively recent years, it is interesting to note from comment on the subject made in the Zeitschrift für Vermessungswesen that it was invented nearly 300 years ago. It is recorded that Gunter shortly after bringing out the trigonometric logarithm tables in 1620 placed logarithmic scales on wooden rules, and used a pair of dividers to add or subtract the logarithms. In 1627 these logarithmic scales were drawn by Wingate on two separate wooden rules, sliding against each other, and thus obviating the necessity of the dividers, and in 1657, or over 250 years ago, Partridge brought out the slide rule, which was more or less similar to the slide rule in its present form.

ENGINEERING NOTES.

A patent has recently been granted in the United States for a blast-furnace construction which is offered as a preventive of hanging and slips and the resultant explosions. With a view to preventing choking of the burden and to secure a positive feed at the bosh, the inventor proposes to make this section of the furnace rotatable. The upper portion of the stack is to be carried on columns in the usual way. For the separate support of the bosh a circular structure of I-beams is provided, the beams being carried on brackets projecting from the columns. On this structure it is proposed to mount a heavy circular bedplate with guides for antifriction rollers, the latter carrying brackets which are secured to the bosh.

The great difference in speed of rolling steel ingots now as compared with twenty years ago and the effect of rapid rolling on the finished material has been made the subject of study by J. E. York. He states that the finishing temperature should be as low as possible to get good results, and that the initial temperature should not be above 950 deg.; if, under these conditions, the ingot cannot be rolled to four rail-lengths in one operation, the initial size should be reduced before rolling. Steel ingots suffer from three defects, viz., pipes, segregation, and blow-holes. Mr. York points out that ordinary mills stretch the metal by rolling, and therefore lengthen both the pipe and ingot simultaneously. The high speed given to rolls in modern mills does not cause inferior rails. Provided the metal is comparatively solid and not overheated, and the rolling action is on correct lines, high rolling speeds will cause no deterioration in the physical properties of the finished product.

An overhead wire-rope tramway, believed to be unlike any other, was recently erected for the Monterey Lime Company, San Francisco, Cal., at its plant about 40 miles below Monterey, by the Hallidie-Painter Tramway Company, successor to the California Wire Works, Oakland, Cal. The tramway runs from the company's kilns to the ocean, approximately 2½ miles, and passes over very rough country. In one place there is a span about 2,600 feet long, and a number of others vary from 800 feet to 1,000 feet. The tramway handles lime in barrels, two barrels to each carrier. The barrels are inclosed in the carriers so that they are completely protected from rain and heavy fogs, which are quite prevalent in that part of the country. Two attendants take care of the tramway, one at the loading and the other at the unloading end. The capacity is fifty barrels per hour. The operation is very simple; the carriers stop to load and unload automatically, and are automatically started when the next carrier comes in. The Monterey Lime Company has found the tramway of considerable benefit to it in the reduction of the cost of lime handling. Previously this was done by teams, and it is stated that the change in the mode of handling the lime has made such a difference to the company that where there was formerly a loss there is now a profit.

The amount of slag produced per ton of iron from the blast furnace varies in amount from ½ ton to about 1½ tons, according to the ores used; and, with the enormous output of pig iron at the present time, it is not surprising that attempts are continually made to find some satisfactory means of turning this material to account. The manufacture of concrete bricks from blast furnace slag has become a commercial process of some value. The material, containing as it does a large amount of lime and silica, is eminently suitable for such a purpose. The granulation of the slag is first effected by running it, while still in a molten condition, into water. After granulation, the slag is passed between squeezing rollers for the purpose of removing the excess of water and crushing any large particles. For mixing with the slag, white unslaked lime has proved most satisfactory, ground to an 8,000 mesh. The lime should not contain more than ½ per cent magnesia. The slag and unslaked lime in proportions of 95 to 93 per cent slag to 5 to 7 per cent lime are tipped into a large hopper and passed thence to a steam jacket mixing machine; the heat, together with the moisture in the slag, starting the reaction of the lime. It is then taken to the presses, in which the pressure is exerted on the 9 x 3-inch side, thus insuring uniform thickness of all bricks, and from these presses the bricks are taken to steaming chambers. The slag must be of uniform gray quality, or variations in the color of the bricks will result. The success of the bricks depends on the care and uniformity with which the various operations are carried out. Uniformity of mixture and of pressing is most important. The moisture carried by the slag, when mixed with the unslaked lime in the mixing hopper, should not be more than 8 to 10 per cent. The resulting bricks compare very favorably with red bricks, and are of a more uniform quality than cement bricks made of zinc slag and lime, or refuse clinker. They have a crushing strength of between 2,500 pounds and 3,000 pounds per square inch, and have withstood very severe treatment.

ELECTRICAL NOTES.

The opening of the Pittsburg, Harmony, Butler, and New Castle Railway gives a new opportunity of observing the operation of an interurban electric traffic system, for which strong claims have been made. The use of direct-current trolley-wire voltages has steadily risen from 500 to 750, but very few installations over 1,000 have been made. It is claimed that this Pittsburg, Harmony, Butler and New Castle Railway is the pioneer high-tension direct-current road of America, as the plans were drawn before those of the Indianapolis and Louisville Railway, which is said to be the first to operate at 1,200 volts. There are 65 miles of single track, and at the Pittsburg end double track is laid for 11.5 miles. The maximum grade is 8 per cent, though 5 per cent is common. With the exception of four miles of 600-volt trolley at the Pittsburg end, the whole system is operated at 1,200 volts.

According to L'Electricien, the Fraser Company, of Bonn, has abandoned the use of crucibles, and is using Stassano furnaces for the manufacture of soft and tool steels. Two furnaces, each of 1 ton capacity, and taking 250 horse-power, are in use, one of which is kept as a standby. Three-phase current at 5,200 volts is used, and is stepped down to 110 volts for employment in the furnace. These furnaces give cast steel containing from 0.08 to 0.18 per cent of carbon, 0.06 per cent of phosphorus, and 0.03 per cent of sulphur. The treatment of the charge usually takes about five hours, 1½ hours of which are necessary for removing the phosphorus and sulphur, and for reducing purposes. The consumption is 900 kilowatt-hours per ton. The furnace employed is of the rotary type, and the results are very satisfactory. The great advantage of this equipment is that low-grade material can be treated, and excellent results thereby obtained.

The possibility of communication by means of wireless telegraphy between balloons and the earth has frequently been mooted, and fears have been expressed that the sparks caused by the signals might give rise to danger in the presence of the inflammable gases used for the inflation of the balloons. Prof. Hergesell has, however, shown, by means of a series of experiments carried out at sea, when radio-telegraphic messages were transmitted between the vessel on which he was sailing and small balloons fitted up with receiving apparatus, that no danger was caused by these signals. He was able, even at a distance of 10 miles, to cause apparatus for operating valves in the balloons to be set in action by means of wireless telegraphy. In the case of the voyage in Belgium of the "Condor" balloon, equipped with radio-telegraphic apparatus, communication was established between the balloon and the signal station for wireless telegraphy on the summit of the Palais de Justice of Brussels, and messages were also received from the Eiffel Tower in Paris by the occupants of the balloon.

According to the Railway Gazette, the New York, New Haven & Hartford Railway's overhead contact line construction, which was designed particularly for rigidity, has given considerable trouble because it was too successful in this respect. It is on the double catenary suspension system, two upper steel messenger wires being connected to the lower copper wire, with which the sliding bow comes in contact, by triangular trolley-hangers spaced 10 feet apart. The sliding bow strikes these points of support a heavy blow, and the triangles are so stiff that breakages result, as well as excessive vibration throughout the structure, and a great deal of sparking. To remedy this, another wire has been strung an inch or two below the old contact wire, being hung from it at points halfway between the triangles. The sliding bow touches this wire only, and the blows at its points or support are cushioned in transmission to the rest of the structure, instead of striking directly the stiff triangles. This has proved so successful that the overhead construction has now been modified in this way over a considerable length of track.

The Pennsylvania Tunnel and Terminal Railway Company has decided to work the traffic through its tunnels on the direct-current third-rail system. This decision is rather unexpected, as tests of the single-phase overhead syystem have been in progress for some time on an experimental track on Long Island. It is now stated that direct current was selected solely because, in the opinion of the engineers of the company, it was best suited for the service to be performed in the electrified zone, and fitted into the system already in use. There have been many rumors that the Pennsylvania Railway would electrify its entire New York division as far as Philadelphia, and even farther west, and this problem has certainly been studied, but the plans considered for the above project have had no influence in determining the system to be employed in the terminal district between Newark and Long Island City. A protected top-contact third rail will be used, and three-phase current at 11,000 volts and with a frequency of 25 will be transmitted from Long Island City power station to sub-stations, where it will be transformed down to 500 volts for use at the third rail.

TRADE NOTES AND FORMULÆ.

Black Leather Color and Restoring Preparation.—2.25 parts of ground ruby shellac, 0.91 part of dark rosin, and 0.115 part of gum rosin and gum sandarac each are dissolved in 22½ parts of methyl alcohol; then add 0.115 part of spirit soluble aniline black, rub 0.115 part of gas black with some of the fluid to a paste and add to it the previous mixture, then filter.

Copying ink, for copying on unmoistened paper, without requiring pressure, is, according to a French patent, made up as follows: 30 parts of aniline dye, 2,000 parts of water, 1,000 parts of glycerine, 15 parts of alum. It suffices to lay a sheet of paper written on with such ink in the letter copy-book and to close it, to obtain a good copy. It is only necessary to insure that the writing is in actual contact with the copy paper.

Artificial Slate.—Good paper is saturated with linseed oil varnish and then coated several times successively with the following mixture, after which the sheets may be written on with lead or slate pencil: one part each of copal varnish, blotting sand and powdered glass, two parts each of oil of turpentine and slate, such as is used for writing-slates, and 1 part of lamp-black, thoroughly mixed together and rubbed down very fine.

Cork Pipe Covering.—This is a mixture of very finely ground cork, asbestos, gypsum, and cement, to be mixed, shortly before use, with water, into a mortar-like paste, and applied like it, by means of a trowel, to the objects to be insulated, such as steam boiler pipes, vacuum and evaporating apparatus, cookers, etc. It answers its purpose much better than the mixtures containing hair, glue, or syrup, as it is subject neither to putrefaction nor fermentation, and is not destroyed by heat. Cork covering material is a bad conductor of heat, accomplishes therefore the most useful results, is very adhesive and durable, and by the saving it effects in fuel soon makes up for its small cost.

To Make Leather Transparent and Hornlike.—According to a new process, the dehaired, but untanned skin, is heated in oil, vaseline, or other fat and obtains thereby a completely hard, hornlike structure. At the same time, by the heating, according to its duration and the temperature to which the fat is heated, a greater thickness is imparted to the leather, which varies according to the structure of the skin. Upon this, as well as upon the original thickness of the skin, and that which it is desired to attain, the duration of the heating depends. The skin thus treated is pressed, dried, smoothed, and finally polished, and after the polishing is almost transparent. Inasmuch as by this process different degrees of hardness may be attained, it is possible to produce a material that can be stamped, embossed, pressed, milled, or worked in other ways.

New Method of Varnish Making.—To dissolve gums or resins, nitrocellulose, etc., without heat, we can use, according to Flemming, the high boiling chlorides of hydrine. In epichloride of hydrine, elemi and mastic are dissolved quickly and completely, either cold or hot. Dammar, Zanzibar copal and Angola copal, easily in the warm, with little residue; Manila copal, easily in the warm, almost completely; Kauri copal, if warm, easily, completely; amber partially and slowly. In dichloride of hydrine, elemi dissolves readily and completely, without warming; dammar and sandarac quite easily, cold; shellac easily, if warm; Zanzibar copal, in the cold; Angola copal and Manila copal, more readily than in epichloride of hydrine; Kauri copal, almost completely. Following is a good recipe: 20 parts of Manila copal are dissolved in 70 parts of epichloride of hydrine in the water-bath, then 100 parts of absolute alcohol added and filtered. The varnish can be used equally well cold or hot as needed, also diluted with a mixture of epichloride of hydrine and alcohol (1 + 5). The coating dries quickly and brilliant and is better able to resist mechanical influences than the ordinary shellac varnishes.

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